CHAPTER 72

ENGINE

LIST OF EFFECTIVE PAGES

N, R or D indicates pages which are New, Revised or Deleted respectively.

Remove and insert the affected pages and complete the Record of Revisions and the Record of Temporary Revisions as necessary.

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LIST OF EFFECTIVE PAGES

N, R or D indicates pages which are New, Revised or Deleted respectively.

Remove and insert the affected pages and complete the Record of Revisions and the Record of Temporary Revisions as necessary.

CH/SE/SU	C	PAGE	DATE	CH/SE/SU	C	PAGE	DATE
S.B.LIST		1	Mar 31/99	S.B.LIST		27	Mar 28/02
S.B.LIST		2	Mar 31/99	S.B.LIST		28	Mar 31/99
S.B.LIST		2 A	Mar 31/99	S.B.LIST		29	Mar 31/99
S.B.LIST		2 B	Mar 31/99	S.B.LIST		30	Mar 31/99
S.B.LIST		3	Nov 30/81	S.B.LIST		31	Mar 31/99
S.B.LIST		4	Mar 31/99	S.B.LIST		32	Mar 31/99
S.B.LIST		4 A	Mar 31/99	S.B.LIST		33	Mar 31/99
S.B.LIST		4 B	Mar 31/99	S.B.LIST		34	Mar 31/99
S.B.LIST		5	Mar 31/95	S.B.LIST		35	Mar 31/99
S.B.LIST		6	Mar 31/00	S.B.LIST		36	Mar 31/99
S.B.LIST		7	Mar 31/00	S.B.LIST		37	Mar 31/99
S.B.LIST		8	Mar 31/99	S.B.LIST		38	Mar 31/99
S.B.LIST		8 A	Mar 31/99	S.B.LIST		39	Mar 31/99
S.B.LIST		8 B	Mar 31/99	S.B.LIST		40	Mar 31/99
S.B.LIST		9	Mar 31/99	S.B.LIST		41	Mar 31/99
S.B.LIST		10	Mar 31/95	S.B.LIST	R	42	May 31/03
S.B.LIST		11	Mar 31/95	S.B.LIST	R	43	May 31/03
S.B.LIST		12	Mar 31/95	S.B.LIST	R	44	May 31/03
S.B.LIST		13	Mar 31/95	S.B.LIST	R	44 A	May 31/03
S.B.LIST		14	Mar 31/99	S.B.LIST		44 B	Mar 31/00
S.B.LIST		15	Mar 31/99	S.B.LIST		45	Mar 31/99
S.B.LIST		16	Mar 31/00	S.B.LIST		46	Mar 30/01
S.B.LIST		16 A	Mar 31/00	S.B.LIST		46 A	Mar 30/01
S.B.LIST		16 B	Mar 31/00	S.B.LIST		46 B	Mar 30/01
S.B.LIST		17	Mar 31/99	S.B.LIST		47	Mar 31/99
S.B.LIST		18	Mar 31/99	S.B.LIST		48	Mar 31/99
S.B.LIST		19	Mar 31/99	S.B.LIST		49	Mar 31/99
S.B.LIST		20	Mar 31/99	S.B.LIST		50	Mar 31/99
S.B.LIST		21	Mar 31/99	S.B.LIST		51	Mar 31/99
S.B.LIST	R	22	May 31/03	S.B.LIST		52	Mar 31/99
S.B.LIST	N	22 A	May 31/03	S.B.LIST		53	Mar 31/99
S.B.LIST	N	22 B	May 31/03	S.B.LIST		54	Mar 31/99
S.B.LIST		23	Mar 31/99	S.B.LIST	R	55	May 31/03
S.B.LIST		24	Mar 31/99	S.B.LIST	R	56	May 31/03
S.B.LIST		25	Mar 28/02	S.B.LIST	N	56 A	May 31/03
S.B.LIST		26	Mar 28/02	S.B.LIST	N	56 B	May 31/03
S.B.LIST		26 A	Mar 28/02	S.B.LIST		57	Mar 31/99
S.B.LIST		26 B	Mar 28/02	S.B.LIST		58	Mar 31/99

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S.B.LIST		59	Mar 30/01	72-01-00		2	Nov 30/75
S.B.LIST		60	Mar 30/01	72-01-00		3	Nov 30/75
S.B.LIST		61	Mar 31/99	72-01-00		4	Nov 30/75
S.B.LIST		62	Mar 31/99	72-01-00		5	Nov 30/75
S.B.LIST		63	Mar 31/99	72-01-00		6	Mar 27/97
S.B.LIST	R	64	May 31/03	72-01-00		7	Nov 30/75
S.B.LIST	R	64 A	May 31/03	72-01-00		8	Mar 27/97
S.B.LIST		64 B	Mar 31/00	72-01-00		9	Mar 27/97
S.B.LIST	R	65	May 31/03	72-01-00		10	Mar 27/97
S.B.LIST	R	66	May 31/03	72-01-00		11	Mar 27/97
S.B.LIST		67	Mar 28/02	72-01-00		12	Mar 27/97
S.B.LIST	R	68	May 31/03	72-01-00		13	Mar 27/97
S.B.LIST		68 A	Mar 28/02	72-01-00		14	Mar 27/97
S.B.LIST		68 B	Mar 28/02	72-01-00		15	Mar 27/97
S.B.LIST		69	Mar 28/02	72-01-00		16	Mar 27/97
S.B.LIST		70	Mar 31/00	72-01-00		101	Feb 28/81
S.B.LIST		71	Mar 30/01	72-01-00		102	Feb 28/81
S.B.LIST		72	Mar 30/01	72-01-00	R	103	May 31/03
S.B.LIST		73	Mar 30/01	72-01-00		104	Sep 30/90
S.B.LIST		74	Mar 30/01	72-01-00	N	104 A	May 31/03
S.B.LIST	R	74 A	May 31/03	72-01-00	N	104 B	May 31/03
S.B.LIST	R	74 B	May 31/03	72-01-00		105	Feb 28/81
S.B.LIST	R	75	May 31/03	72-01-00		106	Feb 28/81
S.B.LIST	R	76	May 31/03	72-01-00		107	Mar 31/98
S.B.LIST	R	77	May 31/03	72-01-00		108	Mar 31/98
S.B.LIST	R	78	May 31/03	72-01-00		109	Mar 31/98
S.B.LIST	R	79	May 31/03	72-01-00		110	Mar 31/98
S.B.LIST	R	80	May 31/03	72-01-00		301	Mar 31/00
S.B.LIST	R	81	May 31/03	72-01-00		302	Mar 31/99
S.B.LIST	N	82	May 31/03	72-01-00		302 A	Mar 31/99
				72-01-00		302 B	Mar 31/00
T. of C.	R	1	May 31/03	72-01-00		302 C	Mar 31/00
T. of C.	R	2	May 31/03	72-01-00		302 D	Mar 31/99
T. of C.		3	Mar 31/00	72-01-00		303	Mar 27/97
T. of C.	R	4	May 31/03	72-01-00		304	Mar 31/99
T. of C.		5	Mar 31/00	72-01-00		305	Mar 31/99
T. of C.		6	Mar 28/02	72-01-00		306	Mar 31/99
T. of C.		7	Mar 28/02	72-01-00		306 A	Mar 31/99
T. of C.		8	Mar 31/00	72-01-00		306 B	Mar 27/97
T. of C.		9	Mar 31/00	72-01-00		307	Mar 31/99
T. of C.		10	Mar 31/00	72-01-00		308	Mar 31/99
T. of C.		11	Mar 31/00	72-01-00		309	Mar 31/98
T. of C.		12	Mar 31/00	72-01-00		310	Aug 30/78
T. of C.		13	Mar 31/00	72-01-00		311	Mar 31/98
				72-01-00		312	Aug 30/78
72-00-00		1	Nov 30/75	72-01-00		313	Mar 31/99
72-00-00		2	Nov 30/75	72-01-00		314	Mar 30/01
72-00-00		3	Nov 30/75	72-01-00		314 A	Mar 30/01
				72-01-00		314 B	Mar 30/01
72-01-00		1	May 30/80	72-01-00		315	Mar 27/97

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72-01-00		316	May 30/79	72-01-00	N	631	May 31/03
72-01-00		317	May 30/79	72-01-00	N	632	May 31/03
72-01-00		318	Mar 27/97	72-01-00	N	633	May 31/03
72-01-00		319	May 30/79	72-01-00	N	634	May 31/03
72-01-00		320	May 30/79	72-01-00	N	635	May 31/03
72-01-00		321	Mar 27/97	72-01-00	N	636	May 31/03
72-01-00		322	Mar 27/97	72-01-00	N	637	May 31/03
72-01-00		323	Mar 27/97	72-01-00	N	638	May 31/03
72-01-00		324	Mar 27/97	72-01-00	N	639	May 31/03
72-01-00		325	Mar 27/97	72-01-00	N	640	May 31/03
72-01-00		326	Mar 27/97	72-01-00	N	641	May 31/03
72-01-00		327	Mar 27/97	72-01-00	N	642	May 31/03
72-01-00		501	Mar 31/98	72-01-00	N	643	May 31/03
72-01-00		502	Nov 30/75	72-01-00	N	644	May 31/03
72-01-00		503	Mar 31/98	72-01-00	N	645	May 31/03
72-01-00		504	Mar 31/98	72-01-00	N	646	May 31/03
72-01-00	R	601	May 31/03	72-01-01		301	Nov 30/75
72-01-00	R	602	May 31/03	72-01-01		401	May 30/76
72-01-00		603	Feb 28/81	72-01-01		402	Nov 30/75
72-01-00	R	604	May 31/03	72-01-01		403	Mar 31/95
72-01-00		604 A	Mar 29/96	72-01-03		401	Mar 31/95
72-01-00		604 B	Mar 29/96	72-01-03		402	May 30/79
72-01-00		605	Feb 28/81	72-01-03		403	Mar 31/95
72-01-00		606	Mar 31/95	72-01-03		404	Mar 31/95
72-01-00		606 A	Mar 27/97	72-01-03		405	Mar 31/95
72-01-00		606 B	Mar 27/97	72-01-03		406	Feb 28/77
72-01-00		607	Mar 31/95	72-01-03		407	May 30/79
72-01-00		608	Mar 31/95	72-01-03		408	May 30/79
72-01-00		609	Mar 31/95	72-01-03		409	May 30/79
72-01-00		610	Feb 28/81	72-01-03		410	May 30/77
72-01-00		611	Feb 28/81	72-01-03		411	May 30/79
72-01-00		612	Feb 28/81	72-01-03		412	Feb 28/81
72-01-00		613	Feb 28/81	72-01-03		413	Feb 28/81
72-01-00		614	Feb 28/81	72-01-03		414	Feb 28/81
72-01-00	N	615	May 31/03	72-01-03		415	Sep 30/87
72-01-00	N	616	May 31/03	72-01-03		416	Feb 28/81
72-01-00	N	617	May 31/03	72-01-03		417	Feb 28/81
72-01-00	N	618	May 31/03	72-01-03		418	Feb 28/81
72-01-00	N	619	May 31/03	72-01-03		419	Feb 28/81
72-01-00	N	620	May 31/03	72-01-03		420	Feb 28/81
72-01-00	N	621	May 31/03	72-01-04		401	Mar 31/95
72-01-00	N	622	May 31/03	72-01-04		402	Feb 28/81
72-01-00	N	623	May 31/03	72-01-04		403	Mar 31/95
72-01-00	N	624	May 31/03	72-01-04		404	Mar 31/95
72-01-00	N	625	May 31/03	72-01-04		405	Mar 31/95
72-01-00	N	626	May 31/03	72-01-04		406	Feb 28/81
72-01-00	N	627	May 31/03	72-01-04		407	Feb 28/81
72-01-00	N	628	May 31/03	72-01-04		408	Feb 28/81
72-01-00	N	629	May 31/03	72-01-04		409	Feb 28/81
72-01-00	N	630	May 31/03	72-01-04		410	Feb 28/81

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72-01-04		411	Feb 28/81	72-10-00		115	Sep 30/87
72-01-04		412	Feb 28/81	72-10-00		116	Sep 30/87
72-01-04		413	Sep 30/87	72-10-00		117	Sep 30/87
72-01-04		414	Nov 30/82	72-10-00		118	Sep 30/87
72-01-04		415	May 30/83	72-10-00		119	Sep 30/87
72-01-04		416	Feb 28/81	72-10-00		120	Sep 30/87
				72-10-00		121	Sep 30/87
72-02-00		1	Nov 30/75				
72-02-00		2	Nov 30/75	72-20-00		1	Sep 30/86
72-02-00		3	Nov 30/75	72-20-00		2	Mar 29/96
72-02-00		4	Nov 30/75	72-20-00		3	Aug 30/79
72-02-00		5	Nov 30/75				
72-02-00		6	Nov 30/75	72-21-01		401	Mar 27/97
72-02-00		7	Nov 30/75	72-21-01		402	Mar 27/97
72-02-00		8	Nov 30/75	72-21-01		403	Mar 27/97
				72-21-01		404	Mar 27/97
72-09-01		201	Mar 31/00	72-21-01		405	Mar 27/97
72-09-01		202	Mar 31/98	72-21-01		406	Mar 27/97
72-09-01		203	Mar 31/98	72-21-01		601	Aug 30/79
72-09-01		204	Mar 31/98	72-21-01		602	Mar 27/97
72-09-01		205	Mar 31/98	72-21-01		602 A	Mar 27/97
72-09-03		201	Sep 30/90	72-21-01		602 B	Mar 27/97
72-09-03		202	May 30/77	72-21-01		603	Mar 27/97
72-09-03		203	Sep 30/90	72-21-01		604	Sep 30/88
72-09-03		204	Sep 30/90	72-21-01		605	Sep 30/88
72-09-03		205	Sep 30/90	72-21-01		606	Sep 30/88
72-09-03		206	Sep 30/90	72-21-01		607	Sep 30/90
72-09-04		201	Aug 30/76	72-21-01		608	Sep 30/90
72-09-04		202	Nov 30/75	72-21-01		609	Sep 30/90
72-09-04		203	Nov 30/75	72-21-01		610	Sep 30/90
72-09-04		204	Nov 30/75	72-21-01		611	Sep 30/90
				72-21-01		612	Sep 30/90
72-10-00	R	101	May 31/03				
72-10-00		102	Mar 31/00	72-22-01		601	Aug 30/76
72-10-00		103	Sep 30/86	72-22-01		602	Aug 30/76
72-10-00		104	Mar 31/00	72-22-01		603	May 30/79
72-10-00		105	Mar 31/00	72-22-01		604	May 30/79
72-10-00		106	Sep 30/86	72-22-01		605	May 30/79
72-10-00		107	Sep 30/86				
72-10-00		108	Sep 30/86	72-23-01		401	Sep 30/86
72-10-00		109	Sep 30/86	72-23-01		402	May 30/79
72-10-00		110	Sep 30/86	72-23-01		403	May 30/79
72-10-00	R	111	May 31/03	72-23-01		404	May 30/79
72-10-00	R	112	May 31/03	72-23-01		405	May 30/79
72-10-00	N	112 A	May 31/03	72-23-01		406	May 30/79
72-10-00	N	112 B	May 31/03	72-23-01		407	May 30/79
72-10-00	N	112 C	May 31/03	72-23-01		408	May 30/79
72-10-00	N	112 D	May 31/03	72-23-01		409	Sep 30/86
72-10-00		113	Sep 30/87				
72-10-00		114	Sep 30/87	72-30-00		1	Nov 30/75

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72-30-00		2	Nov 30/75	72-31-00		813	Mar 31/98
				72-31-00		814	Mar 31/98
72-31-00		1	Nov 30/75	72-31-00		815	Mar 28/02
72-31-00		2	Nov 30/75	72-31-00		816	Mar 28/02
72-31-00		3	Mar 31/95	72-31-00		817	Mar 28/02
72-31-00		4	Nov 30/75	72-31-00		818	Mar 31/98
72-31-00		5	Mar 31/95	72-31-00		819	Mar 31/98
72-31-00		601	Mar 31/98	72-31-00		820	Mar 31/98
72-31-00		602	Mar 31/98	72-31-00		821	Mar 31/98
72-31-00		602 A	Sep 30/90	72-31-00		822	Mar 31/98
72-31-00		602 B	Sep 30/90	72-31-00		823	Mar 31/98
72-31-00		603	Feb 28/81	72-31-00		824	Mar 31/98
72-31-00		604	Feb 28/81				
72-31-00		605	Feb 28/81	72-32-00		1	Nov 30/75
72-31-00		606	Sep 30/92	72-32-00		2	Nov 30/75
72-31-00		607	Mar 31/98				
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72-31-00		609	Mar 31/99	72-33-00		2	Nov 30/75
72-31-00		610	Mar 31/99	72-33-00		3	Mar 31/95
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72-31-00		613	Mar 31/98	72-33-00		602 A	Sep 30/90
72-31-00		614	Mar 31/98	72-33-00		602 B	Sep 30/90
72-31-00		614 A	Mar 31/98	72-33-00		603	Mar 28/02
72-31-00		614 B	Sep 30/92	72-33-00		604	Mar 31/00
72-31-00		615	Mar 31/98	72-33-00		604 A	Mar 31/00
72-31-00		616	Mar 31/98	72-33-00		604 B	Mar 31/00
72-31-00		617	Feb 28/81	72-33-00		605	Mar 28/02
72-31-00		618	Feb 28/81	72-33-00		606	Feb 28/81
72-31-00		619	Feb 28/81	72-33-00		607	Mar 28/02
72-31-00		620	Feb 28/81	72-33-00		608	Feb 28/81
72-31-00		621	Feb 28/81	72-33-00		609	Mar 28/02
72-31-00		622	Sep 30/92	72-33-00		610	Mar 28/02
72-31-00		623	Mar 31/98	72-33-00		610 A	Mar 31/00
72-31-00		624	Sep 30/90	72-33-00		610 B	Mar 30/01
72-31-00		625	Sep 30/90	72-33-00		611	Mar 30/01
72-31-00		801	Mar 28/02	72-33-00		612	Mar 30/01
72-31-00		802	Mar 31/98	72-33-00		613	Feb 28/81
72-31-00		803	Mar 28/02	72-33-00		614	Mar 30/01
72-31-00		804	Mar 28/02	72-33-00		615	Mar 30/01
72-31-00		804 A	Mar 28/02	72-33-00		616	Feb 28/81
72-31-00		804 B	Mar 28/02	72-33-00		617	Feb 28/81
72-31-00		805	Mar 31/98	72-33-00		618	Feb 28/81
72-31-00		806	Mar 31/98	72-33-00		619	Mar 30/01
72-31-00		807	Mar 31/98	72-33-00		620	Feb 28/81
72-31-00		808	Mar 31/98	72-33-00		621	Feb 28/81
72-31-00		809	Mar 31/98	72-33-00		622	Sep 30/92
72-31-00		810	Mar 31/98	72-33-00		623	Sep 30/92
72-31-00		811	Mar 31/98	72-33-00		624	Sep 30/92
72-31-00		812	Mar 31/98	72-33-00		801	Mar 28/02

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72-33-00		802	Mar 31/98
72-33-00		803	Mar 28/02
72-33-00		804	Mar 28/02
72-33-00		804 A	Mar 28/02
72-33-00		804 B	Mar 28/02
72-33-00		805	Mar 28/02
72-33-00		806	Mar 31/98
72-33-00		807	Mar 28/02
72-33-00		808	Mar 31/98
72-33-00		809	Mar 31/98
72-33-00		810	Mar 31/98
72-33-00		811	Mar 31/98
72-33-00		812	Mar 31/98
72-33-00		813	Mar 31/98
72-33-00		814	Mar 31/98
72-33-00		815	Mar 31/98
72-33-00		816	Mar 28/02
72-33-00		817	Mar 28/02
72-33-00		818	Mar 28/02
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72-33-00		821	Mar 31/98
72-33-00		822	Mar 31/98
72-33-00		823	Mar 31/98
72-34-00		1	May 30/80
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72-40-00		1	Mar 31/00
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72-40-00		3	Mar 31/00
72-40-00		4	Mar 31/00
72-41-01		601	Mar 31/00
72-41-01		602	Mar 31/00
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72-41-01		611	Mar 31/00
72-41-01		612	Mar 31/00
72-41-01		613	Mar 31/00
72-41-01	R	614	May 31/03
72-41-01		615	Mar 31/00
72-41-01		616	Mar 31/00
72-41-01		617	Mar 31/00
72-41-01		618	Mar 31/00
72-41-01		619	Mar 31/00
72-41-01		620	Mar 31/00
72-41-01		621	Mar 31/00
72-41-01	R	622	May 31/03
72-41-01		623	Mar 31/00
72-41-01		624	Mar 31/00
72-41-01		625	Mar 31/00
72-41-01		626	Mar 31/00
72-41-01		627	Mar 31/00
72-41-01		628	Mar 31/00
72-41-01		629	Mar 31/00
72-41-01		630	Mar 31/00
72-41-01		631	Mar 31/00
72-41-01		632	Mar 31/00
72-41-01		633	Mar 31/00
72-41-01		634	Mar 31/00
72-41-01		635	Mar 31/00
72-41-01		636	Mar 31/00
72-41-01		637	Mar 31/00
72-41-01		638	Mar 31/00
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72-50-00		604	Feb 28/81
72-50-00		605	Feb 28/81
72-50-00		606	Feb 28/81

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72-51-00		602 A	Sep 30/90
72-51-00		602 B	Sep 30/90
72-51-00		603	Nov 30/83
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72-51-00	R	608 B	May 31/03
72-51-00	R	609	May 31/03
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72-51-00		615	Sep 30/93
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72-51-00		616 A	Sep 30/86
72-51-00		616 B	Sep 30/86
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72-51-00		619	Feb 28/81
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72-51-00		623	Nov 30/82
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72-52-00		602 A	Sep 30/90
72-52-00		602 B	Sep 30/90
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72-52-00	R	605	May 31/03
72-52-00		606	Feb 28/81
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72-52-00	R	608	May 31/03
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72-52-00	N	608 B	May 31/03
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72-54-01		2	Nov 30/75
72-54-01		401	May 30/79
72-54-01		402	Feb 28/77
72-54-01		403	Nov 30/78
72-54-01		404	Sep 30/86
72-54-01		405	May 30/79
72-54-01		406	Nov 30/76
72-54-01		407	Nov 30/76
72-54-01		408	Sep 30/86
72-54-01		409	Sep 30/86
72-54-01		410	Mar 31/99
72-54-01		411	Sep 30/87
72-54-01		412	Sep 30/87
72-54-01		413	Sep 30/87
72-54-01		414	Sep 30/87
72-54-01		415	Feb 28/77
72-54-01		416	Sep 30/86
72-54-01		417	Sep 30/87

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72-54-01		418	May 30/79	72-63-00		6	Mar 27/97
72-54-01		419	May 30/79	72-63-00		7	Mar 27/97
72-54-01		420	May 30/77	72-63-00		301	Nov 30/75
72-54-01		601	Aug 30/79	72-63-00		401	Feb 28/81
72-54-01		602	Aug 30/81	72-63-00		402	Feb 28/81
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72-54-01		807	Feb 28/81	72-63-03		401	May 30/76
72-54-01		808	Feb 28/81	72-63-03		402	May 30/76
72-54-01		809	May 30/82	72-63-03		403	May 30/76
72-54-01		810	Feb 28/81	72-63-05		401	Feb 28/79
72-54-01		811	Feb 28/81	72-63-05		402	May 30/77
72-54-01		812	May 30/82	72-63-05		403	May 30/77
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72-62-00		3	Nov 30/75	72-63-05		417	Feb 28/79
72-62-00		4	Aug 30/79	72-63-05		418	Feb 28/79
72-62-00		5	Aug 30/79	72-63-06		301	Nov 30/75
72-62-00		401	Nov 30/77	72-63-06		401	Mar 31/00
72-62-00		402	Aug 30/77	72-63-06		402	Mar 31/98
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72-63-00		5	Mar 27/97	72-65-00		1	Mar 27/97

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72-65-00		2	Mar 31/98				
72-65-00		3	Aug 30/76				
72-65-00		4	Mar 31/98				
72-65-00		5	Mar 27/97				
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72-65-00		409	Aug 30/77				
72-65-00		410	Aug 30/77				
72-65-00		411	Aug 30/77				
72-65-00		501	Nov 30/75				

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-A119		May 30/77	Embodied
OL 72-001			Applicable Engine - HP turbine bearing support - New No. 4 bearing tube end assembly
R OL 72-001	01		Applicable Engine - HP turbine bearing support - New No.4 bearing tube end assembly
OL 72-002			Applicable Engine - Accessory gearbox case assembly RH - Scavenge oil pump location pins
OL 72-003			Applicable Engine - Drive, pulse probe and housing - Reduced shearing strength and introduction of extractor thread
OL 72-004			Applicable Engine - Scavenge oil pump drive and idler shaft - Introduction of a new oil pump drive bearing
OL 72-005			Applicable Engine - LP compressor rotor - New ring spacers
OL 72-005	01		Applicable Engine - LP compressor rotor - New ring spacers
OL 72-006			Applicable Engine - HP compressor rotor - New shoulder bolts
OL 72-007			Embodied Engine - Accessory gearbox case assembly RH - Modified Metaflex seals and adapters
OL 72-007	01		Embodied Engine - Accessory gearbox case assembly RH - Modified Metaflex seals and adapters
OL 72-008		May 30/77	Embodied Engine - Main oil pump/Accessory gearbox case assembly RH - Introduction of modified relief valve caps
OL 72-008	01		Embodied Engine - Main oil pump/Accessory gearbox case assembly RH - Introduction of modified relief valve caps
OL 72-009			Applicable

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
			Engine - Accessory gearbox case assembly LH - New front cover
OL 72-009	01		Applicable Engine - Accessory gearbox case assembly LH - New front cover
OL 72-010			Applicable Engine - HP compressor case and vanes - Redesigned oil cooler front mounting bracket
OL 72-010	01		Applicable Engine - HP compressor case and vanes - Redesigned oil cooler front mounting bracket
OL 72-011			Applicable Engine - Accessory gearbox case assembly RH - Chamfer added to bolt holes
OL 72-012			Applicable Engine - Accessory gearbox case assembly LH - Redesigned oil jets
OL 72-012	01		Applicable Engine - Accessory gearbox case assembly LH - Redesigned oil jets
OL 72-013			Applicable Engine - HP compressor rotor - Revised oil drainage
OL 72-014			Applicable Engine - HP compressor rotor - New thrust bearings (No. 3)
OL 72-015			Applicable Engine - Accessory gearbox case assembly LH/LP compressor rotor front bearing support - Introduction of Klingerit gaskets
R OL 72-015	01		Applicable Engine - Accessory gearbox case assembly LH/LP compressor rotor front bearing support - Introduction of Klingerit gaskets
OL 72-016			Applicable Engine - Tube assemblies various - Deletion of alternative tube assemblies

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-017			Applicable Engine - Bearings various - New bearing housing assemblies for numbers 1, 2, 3, 4 and 5 bearings
OL 72-017	01		Applicable Engine - Bearings various - New bearing housing assemblies for numbers 1, 2, 3, 4 and 5 bearings
OL 72-018			Applicable

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SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
			Engine -Accessory gearbox case assembly LH/Main oil pump -New hollow pins
OL 72-018	01		Applicable Engine -Accessory gearbox case assembly LH/Main oil pump -New hollow pins
OL 72-019			Applicable Engine -LP compressor case and vanes - Flame plating
OL 72-019	01		Applicable Engine -LP compressor case and vanes - Flame plating
OL 72-020			Applicable Engine -HP turbine bearing support/LP turbine bearing support -Improved heat insulation blankets
OL 72-020	01		Applicable Engine -HP turbine bearing support/LP turbine bearing support -Improved heat insulation blankets
OL 72-020	02		Applicable Engine -HP turbine bearing support/LP turbine bearing support -Improved heat insulation blankets
OL 72-021			Applicable Engine -LP compressor rotor/compressor intermediate case -New oil thrower, bevel driver gear and adjusting washers
OL 72-021	01		Applicable Engine -LP compressor rotor/compressor intermediate case -New oil thrower, bevel driver gear and adjusting washers
OL 72-022			Embodied Engine -LP turbine rotor -Introduction of LP turbine blade assembly incorporating bridge pieces and increased shroud clearance
OL 72-022	01		Applicable Engine -LP turbine rotor -Introduction of LP turbine blade assembly incorporating bridge pieces and increased shroud clearance
OL 72-022	02		Applicable Engine -LP turbine rotor -Introduction of LP turbine blade assembly incorporating

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SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
			bridge pieces and increase shroud clearance
OL 72-023			Applicable Engine - Accessory gearbox case assembly RH - Blanking of negative 'G' filter and replacement of pressure pump gears
OL 72-024			Applicable Engine - Accessory gearbox case assembly RH - Introduction of aluminium allow hollow pins
R OL 72-024	01		Applicable Engine - Accessory gearbox case assembly RH - Introduction of aluminium allow hollow pins
OL 72-025			Applicable Engine - LP compressor rotor/HP compressor rotor - Disks with machined slot
OL 72-025	01		Applicable Engine - LP compressor rotor/HP compressor rotor - Disks with machined slot
OL 72-025	02		Applicable Engine - LP compressor rotor/HP compressor rotor - Disks with machined slot
OL 72-025	03		Applicable Engine - LP compressor rotor/HP compressor rotor - Disks with machined slot
OL 72-025	04		Applicable Engine - LP compressor rotor/HP compressor rotor - Disks with machined slot
OL 72-025	05		Applicable Engine - LP compressor rotor/HP compressor rotor - Disks with machined slot
OL 72-026			Applicable Engine - HP turbine nozzles - Introduction of new cranked stator pin

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-026	01		Applicable Engine - HP turbine nozzles - Introduction of new cranked stator pin
OL 72-026	02		Applicable Engine - HP turbine nozzles - Introduction of new cranked stator pin

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION

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SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-027			Embodied Engine - Main oil pump - Introduction of non-reversible retaining rings
OL 72-027	01		Embodied Engine - Main oil pump - Introduction of non-reversible retaining rings
OL 72-028			Applicable Engine - Compressor intermediate case assembly - New No.2 bearing thrust washer
OL 72-029	01		Applicable Engine - Compressor intermediate case assembly/HP compressor rotor/internal accessory drives - New oil thrower and adjusting washers
OL 72-029	02		Applicable Engine - Compressor intermediate case assembly/HP compressor rotor/internal accessory drives - New oil thrower and adjusting washers
OL 72-030			Applicable Engine - LP compressor rotor (includes LP compressor front bearing inner track) - New shaft cover, rotor shaft and front bearing
OL 72-030	01		Applicable Engine - LP compressor rotor (includes LP compressor front bearing inner track) - New shaft cover, rotor shaft and front bearing
OL 72-031			Applicable Engine - Turbine exhaust diffuser assembly - Introduction of new standard inner and outer case assemblies
OL 72-032			Applicable Engine - Accessory gearbox case assembly LH/main drives accessory gearbox LH - Modified oil jet assembly and additional oil jet in new strainer
OL 72-032	01		Applicable Engine - Accessory gearbox case assembly LH/main drives accessory gearbox LH - Modified oil jet assembly and additional oil jet in new strainer

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-033			Applicable Engine - HP compressor case and vanes - Modified flange bolts
OL 72-033	01		Applicable Engine - HP compressor case and vanes - Modified flange bolts
OL 72-034			Applicable Engine - HP compressor rotor - Disk identification
OL 72-034	01		Applicable Engine - HP compressor rotor - Disk identification
OL 72-034	02		Applicable Engine - HP compressor rotor - Disk identification
OL 72-034	03		Applicable Engine - HP compressor rotor - Disk identification
OL 72-034	04		Applicable Engine - HP compressor rotor - Disk identification
OL 72-034	05		Applicable Engine - HP compressor rotor - Disk identification
R OL 72-034	06		Applicable Engine - HP compressor rotor - Disk identification
OL 72-035			Applicable Engine - Air intake case - Introduction of Klingerit gaskets
OL 72-035	01		Applicable Engine - Air intake case - Introduction of Klingerit gaskets
OL 72-036			Applicable Engine - Main drives accessory gearbox LH - Introduction of stainless steel retaining ring
OL 72-036	01		Applicable Engine - Main drives accessory gearbox LH - Introduction of stainless steel retaining ring

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-037			Applicable Engine - LP compressor case and vanes/LP compressor exit guide case and vanes - Provision for bolting vanes deleted
OL 72-038			Applicable Engine - HP compressor case and vanes - New case HP compressor front assembly
OL 72-039			Applicable Engine - HP turbine bearing support - New oil lubricating nozzle
OL 72-040			Applicable Engine - LP turbine bearing support - Oil feed orifices increased in size
OL 72-040	01		Applicable Engine - LP turbine bearing support - Oil feed orifices increased in size
OL 72-040	02		Applicable Engine - LP turbine bearing support - Oil feed orifices increased in size
OL 72-041			Applicable Engine - Accessory gearbox case assembly RH/drive pulse probe and housing - Modified blank covers
OL 72-042			Applicable Engine - LP turbine nozzle - Various
OL 72-043			Applicable Engine - HP turbine rotor - New rotor blades with stellite bridge piece brazed to shroud
OL 72-044			Applicable Engine - LP turbine nozzles - revised throat area drawing
OL 72-044	01		Applicable Engine - LP turbine nozzles - revised throat area drawing
OL 72-045			Applicable Engine - Drawing LP compressor case and vanes - Modified vane fixing ring assemblies stages 4, 5 and 6
OL 72-045	01		Applicable Engine - Drawing LP compressor case and vanes - Modified vane fixing ring assemblies stages 4, 5 and 6

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-046			Applicable Engine - LP compressor rotor front bearing support - Additional lubricating oil drainage holes
	OL 72-046	01		Applicable Engine - LP compressor rotor front bearing support - Additional lubricating oil drainage holes
R	OL 72-046	02		Applicable Engine - LP compressor rotor front bearing support - Additional lubricating oil drainage holes
	OL 72-047			Applicable Engine - Power plant - Main oil pump/ Tubes component connections to overboard spill - New brackets
	OL 72-048			Applicable Engine - Turbine exhaust diffuser assembly - New oil feed tube and new cold vent tube
	OL 72-048	01		Applicable Engine - Turbine exhaust diffuser assembly - New oil feed tube and new cold vent tube
	OL 72-049			Embodied Engine - Main oil pump - New fine mesh delivery pressure strainer.
	OL 72-049	01		Embodied Engine - Main oil pump - New fine mesh delivery pressure strainer.
	OL 72-049	02		Embodied Engine - Main oil pump - New fine mesh delivery pressure strainer.
	OL 72-050			Applicable Engine - LP turbine bearing support - New rear cover assembly
	OL 72-050	01		Applicable Engine - LP turbine bearing support - New rear cover assembly
	OL 72-050	02		Applicable Engine - LP turbine bearing support - New rear cover assembly

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-051			Applicable Engine - Combustion chamber - New combustion chamber assembly
OL 72-051	01		Applicable Engine - Combustion chamber - New combustion chamber assembly
OL 72-051	02		Applicable Engine - Combustion chamber - New combustion chamber assembly
OL 72-052			Applicable Engine - LP turbine bearing support - New oil feed tube
OL 72-052	01		Applicable Engine - LP turbine bearing support - New oil feed tube

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SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-053			Applicable Engine - Main oil pump - Modified case assembly
OL 72-053	01		Applicable Engine - Main oil pump - Modified case assembly
OL 72-053	02		Applicable Engine - Main oil pump - Modified case assembly
OL 72-054			Applicable Engine - LP compressor case and vanes - New 4th stage vanes
OL 72-054	01		Applicable Engine - LP compressor case and vanes - New 4th stage vanes
OL 72-054	02		Applicable Engine - LP compressor case and vanes - New 4th stage vanes
OL 72-054	03		Applicable Engine - LP compressor case and vanes - New 4th stage vanes
OL 72-054	04		Applicable Engine - LP compressor case and vanes - New 4th stage vanes
R OL 72-054	05		Applicable Engine - LP compressor case and vanes - New 4th stage vanes
OL 72-055			Applicable Engine - Main drives accessory gearbox LH Introduction of washer
OL 72-056			Applicable Engine - Compressor intermediate case assembly - Outer labyrinth housing with thickness at sealing area increased
OL 72-056	01		Applicable Engine - Compressor intermediate case assembly - Outer labyrinth housing with thickness at sealing area increased
OL 72-057			Applicable Engine - Main oil pump - New pressure pump case
OL 72-057	01		Applicable Engine - Main oil pump - New pressure pump case

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-058			Embodied Engine/Engine fuel and control - Combustion chamber outer case (CCOC)/ Fuel sprayers (pilot) - Introduction of gaskets
OL 72-058	01		Applicable Engine/Engine fuel and control - Combustion chamber outer case (CCOC)/ Fuel sprayers (pilot) - Introduction of gaskets
OL 72-058	02		Applicable Engine/Engine fuel and control - Combustion chamber outer case (CCOC)/ Fuel sprayers (pilot) - Introduction of gaskets
OL 72-058	03		Applicable Engine/Engine fuel and control - Combustion chamber outer case (CCOC)/ Fuel sprayers (pilot) - Introduction of gaskets
OL 72-058	04		Applicable Engine/Engine fuel and control - Combustion chamber outer case (CCOC)/ Fuel sprayers (pilot) - Introduction of gaskets
OL 72-058	05		Applicable Engine/Engine fuel and control - Combustion chamber outer case (CCOC)/ Fuel sprayers (pilot) - Introduction of gaskets
OL 72-059			Applicable Engine - HP turbine rotor/LP turbine rotor - Alternative method of manufacture
OL 72-059	01		Applicable Engine - HP turbine rotor/LP turbine rotor - Alternative method of manufacture
OL 72-059	02		Applicable Engine - HP turbine rotor/LP turbine rotor - Alternative method of manufacture
OL 72-060			Applicable Engine - Accessory gearbox case assembly LH - New gearbox case

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-060	01		Applicable Engine - Accessory gearbox case assembly LH - New gearbox case
OL 72-061			Applicable Engine - Accessory gearbox case assembly RH - Introduction of shortened inserts
OL 72-061	01		Applicable Engine - Accessory gearbox case assembly RH - Introduction of shortened inserts
OL 72-062			Applicable Engine - Combustion chamber outer case (CCOC) - New outer case
OL 72-062	01		Applicable Engine - Combustion chamber outer case (CCOC) - New outer case
OL 72-063			Applicable Engine - Combustion chamber outer case - New bracket
OL 72-063	01		Applicable Engine - Combustion chamber outer case - New bracket
OL 72-064			Applicable Engine - Combustion chamber/HP turbine nozzles - Introduction of butt joint and deletion of spacer rings
OL 72-064	01		Applicable Engine - Combustion chamber/HP turbine nozzles - Introduction of butt joint and deletion of spacer rings
OL 72-064	02		Applicable Engine - Combustion chamber/HP turbine nozzles - Introduction of butt joint and deletion of spacer rings
OL 72-065			Applicable Engine - HP compressor rotor - Shot peening of rotor blades
OL 72-065	01		Applicable Engine - HP compressor rotor - Shot peening of rotor blades
OL 72-065	02		Applicable Engine - HP compressor rotor - Shot peening of rotor blades

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-065	03		Applicable Engine - HP compressor rotor - Shot peening of rotor blades
	OL 72-065	04		Applicable Engine - HP compressor rotor - Shot peening of rotor blades
R	OL 72-065	05		Applicable Engine - HP compressor rotor - Shot peening of rotor blades
R	OL 72-065	06		Applicable Engine - HP compressor rotor - Shot peening of rotor blades
R	OL 72-065	07		Applicable Engine - HP compressor rotor - Shot peening of rotor blades
	OL 72-066			Applicable Engine - Compressor intermediate case assembly - Introduction of fire containment covers
	OL 72-067			Applicable Engine - HP compressor rotor - Shot peening of rotor blades
	OL 72-067	01		Applicable Engine - HP compressor rotor - Shot peening of rotor blades
	OL 72-067	02		Applicable Engine - HP compressor rotor - Shot peening of rotor blades
	OL 72-067	03		Applicable Engine - HP compressor rotor - Shot peening of rotor blades
	OL 72-067	04		Applicable Engine - HP compressor rotor - Shot peening of rotor blades
	OL 72-067	05		Applicable Engine - HP compressor rotor - Shot peening of rotor blades
R	OL 72-067	06		Applicable Engine - HP compressor rotor - Shot peening of rotor blades
R	OL 72-067	07		Applicable Engine - HP compressor rotor - Shot peening of rotor blades

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-068			Applicable Engine - HP compressor case and vanes - Modified oil cooler mounting bracket
OL 72-069			Applicable Engine - Essential modifications - Introduction of group modifications
OL 72-070			Applicable Engine - Spherical flange adapter seal cover, removable - Incorporation of
OL 72-070	01		Applicable Engine - Spherical flange adapter seal cover, removable - Incorporation of
OL 72-070	02		Applicable Engine - Spherical flange adapter seal cover, removable - Incorporation of
OL 72-070	03		Applicable Engine - Spherical flange adapter seal cover, removable - Incorporation of
OL 72-070	04		Applicable Engine - Spherical flange adapter seal cover, removable - Incorporation of
OL 72-070	05		Applicable Engine - Spherical flange adapter seal cover, removable - Incorporation of
OL 72-070	06		Applicable Engine - Spherical flange adapter seal cover, removable - Incorporation of
OL 72-071			Applicable Engine - Compressor intermediate case assembly - Addition of assembly tool access hole.
OL 72-071	01		Applicable Engine - Compressor intermediate case assembly - Addition of assembly tool access hole.
OL 72-072			Applicable Engine - LP compressor case and vanes - Introduction of flame plating treatment on 1st stage compressor vanes
OL 72-073			Applicable Engine - HP compressor rotor - Introduction of plain washers for the first stage rotor disk rim bolts

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-074			Applicable Engine - Compressor intermediate case assembly - Bearing housing lands plasma sprayed
OL 72-075			Applicable Engine - Combustion chamber outer case - Revised cooling air supply
OL 72-075	01		Applicable Engine - Combustion chamber outer case - Revised cooling air supply
OL 72-076			Applicable Engine - LP compressor rotor front bearing support - Modified bearing housing and retainer
OL 72-076	01		Applicable Engine - LP compressor rotor front bearing support - Modified bearing housing and retainer
R OL 72-076	02		Applicable Engine - LP compressor rotor front bearing support - Modified bearing housing and retainer
OL 72-077			Applicable Engine - LP compressor drive shaft - assembly
OL 72-078			Applicable Engine - HP compressor rotor - Introduction of longer bolts
OL 72-078	01		Applicable Engine - HP compressor rotor - Introduction of longer bolts
OL 72-079			Applicable Engine - LP and HP compressor case and turbine bearings - Change of material
OL 72-080			Applicable Engine - Air intake case - Introduction of nut retainers and longer bolts
OL 72-081			Applicable Engine - HP turbine bearing support - New restraining brackets
OL 72-082			Applicable Engine - HP compressor diffuser case assembly - Longer union

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-083			Applicable Engine - Accessory gearbox case assembly RH - Improved sealing of oil jet assemblies
OL 72-083	01		Applicable Engine - Accessory gearbox case assembly RH - Improved sealing of oil jet assemblies
OL 72-083	02		Applicable Engine - Accessory gearbox case assembly RH - Improved sealing of oil jet assemblies
OL 72-084			Applicable Engine/Air - Turbine exhaust diffuser/ Tubes oil feed and scavenge/HP turbine bearing support/Tubes air cooling - Thermal insulation blankets - Introduction of revised material
OL 72-084	01		Applicable Engine/Air - Turbine exhaust diffuser/ Tubes oil feed and scavenge/HP turbine bearing support/Tubes air cooling - Thermal insulation blankets - Introduction of revised material
OL 72-085			Applicable Engine - Combustion chamber outer case - Revised turbine nozzle cooling
OL 72-085	01		Applicable Engine - Combustion chamber outer case - Revised turbine nozzle cooling
R OL 72-085	02		Applicable Engine - Combustion chamber outer case - Revised turbine nozzle cooling
OL 72-086			Applicable Engine - HP turbine bearing support - HP turbine nozzle - Modular interface adjusting washers with revised thickness graduations
OL 72-086	01		Applicable Engine - HP turbine bearing support - HP turbine nozzle - Modular interface adjusting washers with revised thickness graduations

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-087			Applicable Engine - HP turbine rotor hub and labyrinth assembly - Inspection of HP turbine rotor disk retaining bolts
OL 72-087	01		Applicable Engine - HP turbine rotor hub and labyrinth assembly - Inspection of HP turbine rotor disk retaining bolts
OL 72-087	02		Applicable Engine - HP turbine rotor hub and labyrinth assembly - Inspection of HP turbine rotor disk retaining bolts
OL 72-088			Applicable Engine - Combustion chamber outer case (CCOC) - Inspection for correct positioning of blanking plates
OL 72-088	01		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection for correct positioning of blanking plates
R OL 72-088	02		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection for correct positioning of blanking plates
OL 72-089			Applicable Engine - LP turbine nozzles - Revised throat area
OL 72-090			Applicable Engine - Main drives accessory gearbox LH - Modified zerol bevel gear assembly
OL 72-090	01		Applicable Engine - Main drives accessory gearbox LH - Modified zerol bevel gear assembly
OL 72-090	02		Applicable Engine - Main drives accessory gearbox LH - Modified zerol bevel gear assembly
OL 72-090	03		Applicable Engine - Main drives accessory gearbox LH - Modified zerol bevel gear assembly
OL 72-090	04		Applicable Engine - Main drives accessory gearbox LH - Modified zerol bevel gear assembly

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-090	05		Applicable Engine - Main drives accessory gearbox LH - Modified zerol bevel gear assembly

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*              R    INC.                                                  *
*SB/AEB NO     E     IN                    DESCRIPTION                    *
*              V   REVISION                                               *
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SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-090	06		Applicable Engine - Main drives accessory gearbox LH - Modified zerol bevel gear assembly
OL 72-091			Applicable Engine - HP compressor rotor/Compressor intermediate case assembly - Reclaimed HP front rotor shaft - Nos. 6, 7 and 8 labyrinth housings with abradable coatings
R OL 72-091	01		Applicable Engine - HP compressor rotor/Compressor intermediate case assembly - Reclaimed HP front rotor shaft - Nos. 6, 7 and 8 labyrinth housings with abradable coatings
OL 72-092			Applicable Engine - HP compressor - Modified fir-tree roots
OL 72-092	01		Applicable Engine - HP compressor - Modified fir-tree roots
OL 72-092	02		Applicable Engine - HP compressor - Modified fir-tree roots
OL 72-092	03		Applicable Engine - HP compressor - Modified fir-tree roots
OL 72-092	04		Applicable Engine - HP compressor - Modified fir-tree roots
OL 72-092	05		Applicable Engine - HP compressor - Modified fir-tree roots
OL 72-092	06		Applicable Engine - HP compressor - Modified fir-tree roots
OL 72-092	07		Applicable Engine - HP compressor - Modified fir-tree roots
OL 72-092	08		Applicable Engine - HP compressor - Modified fir-tree roots

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
R	OL 72-092	09		Applicable Engine - HP compressor - Modified fir-tree roots
	OL 72-093			Applicable Engine - LP compressor rotor/Compressor intermediate case assembly/Shaft drive compressor LP - Nos. 4, 5, 9A and 9B labyrinth housings with abradable coatings
R	OL 72-093	01		Applicable Engine - LP compressor rotor/Compressor intermediate case assembly/Shaft drive compressor LP - Nos. 4, 5, 9A and 9B labyrinth housings with abradable coatings
	OL 72-094			Applicable Engine - HP rotor hub and labyrinth assemblies/LP compressor drive shaft - Additional range of adjusting washers
	OL 72-094	01		Applicable Engine - HP rotor hub and labyrinth assemblies/LP compressor drive shaft - Additional range of adjusting washers
	OL 72-095			Applicable Engine - LP compressor rotor - Modified probe operating ring
	OL 72-096			Embodied Engine/Oil - Accessory gearbox case assembly RH - Deletion of oil pressure transmitter and oil pressure switch
	OL 72-097			Applicable Engine - Compressor intermediate case assembly/Accessory gearbox case assembly LH/Accessory gearbox case assembly RH/LP compressor exit guide case and vanes modular attachment - Transfer of mounting brackets and associated parts
	OL 72-098			Applicable Engine - LP compressor drive shaft - Introduction of strengthened shafts
	OL 72-099			Applicable Engine - HP compressor rotor - New 7th stage rotor disk rim bolts

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-100			Applicable Engine - LP compressor drive shaft - Additional balancing weights
OL 72-100	01		Applicable Engine - LP compressor drive shaft - Additional balancing weights
OL 72-101		May 30/77	Embodied Engine - Turbine exhaust diffuser assemblies - Pre-bent No. 5 bearing oil tubes
OL 72-101	01		Embodied Engine - Turbine exhaust diffuser assemblies - Pre-bent No. 5 bearing oil tubes
OL 72-102		May 30/77	Embodied Engine - Turbine exhaust diffuser assembly - Deletion of thermal insulation blankets
OL 72-102	01		Embodied Engine - Turbine exhaust diffuser assembly - Deletion of thermal insulation blankets
OL 72-102	02		Applicable Engine - Turbine exhaust diffuser assembly - Deletion of thermal insulation blankets
OL 72-103			Applicable Engine - Accessory gearbox case assembly LH - Introduction of hollow pins and retaining plates
OL 72-103	01		Applicable Engine - Accessory gearbox case assembly LH - Introduction of hollow pins and retaining plates
OL 72-104			Applicable Engine - HP compressor - New 1st and 2nd stage stator vanes and inner fixing rings with flame plated abutment faces
R OL 72-104	01		Applicable Engine - HP compressor - New 1st and 2nd stage stator vanes and inner fixing rings with flame plated abutment faces

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-105			Applicable Engine - Various - Inspection of self-locking shaft nuts
OL 72-105	01		Applicable Engine - Various - Inspection of self-locking shaft nuts
OL 72-105	02		Applicable Engine - Various - Inspection of self-locking shaft nuts
OL 72-106			Applicable Engine - Air intake case - Modified case and vibration transducer cable tubes
OL 72-106	01		Applicable Engine - Air intake case = Modified case and vibration transducer cable tubes
OL 72-106	02		Applicable Engine - Air intake case - Modified case and vibration transducer cable tubes
OL 72-107			Applicable Engine - Accessory gearbox case assembly RH - Plug (pressure filter drain) increased in length
OL 72-108			Embodied Engine - Improvement of spherical flange adapter reliability
OL 72-108	01		Applicable Engine - Improvement of spherical flange adapter reliability
OL 72-108	02		Applicable Engine - Improvement of spherical flange adapter reliability
OL 72-108	03		Applicable Engine - Improvement of spherical flange adapter reliability
OL 72-108	04		Applicable Engine - Improvement of spherical flange adapter reliability
OL 72-108	05		Applicable Engine - Improvement of spherical flange adapter reliability
OL 72-109			Applicable Engine - Main drives accessory gearbox RH - Modified keywasher flange

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-110			Applicable Engine - LP compressor exit guide case and vanes - New sealing rings and new retaining rings
R OL 72-110	01		Applicable Engine - LP compressor exit guide case and vanes - New sealing rings and new retaining rings
OL 72-111			Applicable Engine - Accessory gearbox case assembly, RH - Revised oil jet angle
OL 72-111	01		Applicable Engine - Accessory gearbox case assembly, RH - Revised oil jet angle
OL 72-112			Embodied Engine - Main oil pump- Reduced length strainer assembly (pressure)
OL 72-112	01		Applicable Engine - Main oil pump- Reduced length strainer assembly (pressure)
OL 72-113			Applicable Engine - HP turbine rotor - Blanking No. 24 labyrinth balance holes
OL 72-113	01		Applicable Engine - HP turbine rotor - Blanking No. 24 labyrinth balance holes
OL 72-114			Applicable Engine - HP turbine bearing support - Introduction of modified bracket
OL 72-115			Applicable Engine - Various - Introduction of UNS threaded bolts and nuts
OL 72-115	01		Applicable Engine - Various - Introduction of UNS threaded bolts and nuts
OL 72-116			Applicable Engine - Accessory gearbox case assembly RH - QAD coupling - Introduction of shorter straight headless pin
OL 72-117			Applicable Engine - Main oil pump - Modified HP turbine bearing oil scavenge pump filter cover

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-118			Applicable Engine - Accessory gearbox case assembly - RH - Modified IDG/QAD plain flange
	OL 72-118	01		Applicable Engine - Accessory gearbox case assembly - RH - Modified IDG/QAD plain flange
	OL 72-118	02		Applicable Engine - Accessory gearbox case assembly - RH - Modified IDG/QAD plain flange
R	OL 72-A119			Superceded by OL 72-119
R	OL 72-A119	01		Superceded by OL 72-119
R	OL 72-A119	02		Superceded by OL 72-119
R	OL 72-A119	03		Superceded by OL 72-119
	OL 72-119			Applicable Engine - Turbine exhaust diffuser - Inspection of LP turbine bearing (no. 5 bearing) oil feed and scavenge tubes
	OL 72-119	01		Applicable Engine - Turbine exhaust diffuser - Inspection of LP turbine bearing (no. 5 bearing) oil feed and scavenge tubes
	OL 72-119	02		Applicable Engine - Turbine exhaust diffuser - Inspection of LP turbine bearing (no. 5 bearing) oil feed and scavenge tubes
	OL 72-119	03		Applicable Engine - Turbine exhaust diffuser - Inspection of LP turbine bearing (no. 5 bearing) oil feed and scavenge tubes
	OL 72-120			Applicable Engine - LP turbine bearing support - Modification insulation blankets at bearing scavenge oil tube
R	OL 72-120	01		Applicable Engine - LP turbine bearing support - Modification insulation blankets at bearing scavenge oil tube
	OL 72-121		May 30/77	Embodied Engine - LP turbine bearing support - Deletion of insulation blankets at bearing feed and scavenge tubes inner locations

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-121	01		Applicable Engine - LP turbine bearing support - Deletion of insulation blankets at bearing feed and scavenge tubes inner locations
OL 72-121	02		Applicable Engine - LP turbine bearing support - Deletion of insulation blankets at bearing feed and scavenge tubes inner locations
R OL 72-121	03		Applicable Engine - LP turbine bearing support - Deletion of insulation blankets at bearing feed and scavenge tubes inner locations

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION

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SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-122			Applicable Engine - HP compressor rotor - Stage 3, 5 and 6 compressor blades with increased tang chamfer
R OL 72-122	01		Applicable Engine - HP compressor rotor - Stage 3, 5 and 6 compressor blades with increased tang chamfer
OL 72-123			Applicable Engine - HP compressor rotor - Revised No.12 labyrinth eccentric setting
OL 72-123	01		Applicable Engine - HP compressor rotor - Revised No.12 labyrinth eccentric setting
OL 72-124			Applicable Engine - HP turbine nozzle - Introduction of sealing strips at HP nozzle vane assembly platforms
OL 72-124	01		Applicable Engine - HP turbine nozzle - Introduction of sealing strips at HP nozzle vane assembly platforms
OL 72-125			Applicable Engine - HP compressor case and vanes - Introduction of modified air supply block
OL 72-126			Applicable Engine - HP compressor case and vanes - Introduction of silver plated intrascope blank plug assemblies
R OL 72-126	01		Applicable Engine - HP compressor case and vanes - Introduction of silver plated intrascope blank plug assemblies
OL 72-127			Applicable Engine - LH accessory gearbox assembly - Transfer of installation fittings
OL 72-128			Applicable Engine - RH accessory gearbox assembly - Transfer of installation fittings
OL 72-129			Applicable Engine - Diffuser turbine exhaust - Introduction of contoured duct, air, assemblies of

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-129	01		Applicable Engine - Diffuser turbine exhaust - Introduction of contoured duct, air, assemblies of
OL 72-129	02		Applicable Engine - Diffuser turbine exhaust - Introduction of contoured duct, air, assemblies of
OL 72-129	03		Applicable Engine - Diffuser turbine exhaust - Introduction of contoured duct, air, assemblies of
OL 72-129	04		Applicable Engine - Diffuser turbine exhaust - Introduction of contoured duct, air, assemblies of
OL 72-129	05		Applicable Engine - Diffuser turbine exhaust - Introduction of contoured duct, air, assemblies of
OL 72-129	06		Applicable Engine - Diffuser turbine exhaust - Introduction of contoured duct, air, assemblies of
OL 72-130			Applicable Engine - Diffuser turbine exhaust - Improved fastenings for duct, air, assemblies of
OL 72-130	01		Applicable Engine - Diffuser turbine exhaust - Improved fastenings for duct, air, assemblies of
OL 72-131			Embodied Engine - LH accessory gearbox assembly - Introduction of simplified washer plate
OL 72-132			Not Applicable
OL 72-133			Applicable Engine - Internal accessory drives - Introduction of modified bearing housing

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-134			Applicable Engine - Various - Introduction of shorter bolts to provide tool access
OL 72-135			Applicable Engine - Compressor intermediate case assembly - Modified inner case assembly
OL 72-136			Applicable Engine - HP compressor rotor - Modified retaining bolts
OL 72-136	01		Applicable Engine - HP compressor rotor - Modified retaining bolts
OL 72-136	02		Applicable Engine - HP compressor rotor - Modified retaining bolts
OL 72-137			Applicable Engine - HP compressor diffuser case assembly - Shortened HP turbine oil scavenge tube insulated assembly
OL 72-138			Applicable Engine - HP compressor diffuser case assembly - Introduction of modified inner and outer sleeves
OL 72-138	01		Applicable Engine - HP compressor diffuser case assembly - Introduction of modified inner and outer sleeves
OL 72-138	02		Applicable Engine - HP compressor diffuser case assembly - Introduction of modified inner and outer sleeves
OL 72-140			Applicable Engine - LP compressor case fittings - Revised mounting plate bracket assembly (rear)
R OL 72-140	01		Not Applicable Engine - LP compressor case fittings - Revised mounting plate bracket assembly (rear)

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
R OL 72-140	02		Not Applicable Engine - LP compressor case fittings - Revised mounting plate bracket assembly (rear)
OL 72-141			Applicable Engine - LP compressor exit guide case and vanes/LP compressor rotor/HP compressor case and vanes/HP compressor rotor - Alternative vanes and blades
OL 72-142			Applicable Engine - LP compressor rotor (includes LP compressor front bearing inner track) - Introduction of first stage blades having fir-tree and root neck shot peened
OL 72-143			Applicable Engine - LP compressor rotor blades stage 5 - Inspection of blade roots
OL 72-143	01		Applicable Engine - LP compressor rotor blades stage 5 - Inspection of blade roots
OL 72-143	02		Applicable Engine - LP compressor rotor blades stage 5 - Inspection of blade roots
OL 72-143	03		Applicable Engine - LP compressor rotor blades stage 5 - Inspection of blade roots
OL 72-143	04		Applicable Engine - LP compressor rotor blades stage 5 - Inspection of blade roots
OL 72-143	05		Applicable Engine - LP compressor rotor blades stage 5 - Inspection of blade roots
OL 72-143	06		Applicable Engine - LP compressor rotor blades stage 5 - Inspection of blade roots
OL 72-143	07		Applicable Engine - LP compressor rotor blades stage 5 - Inspection of blade roots

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-143	08		Applicable Engine - LP compressor rotor blades stage 5 - Inspection of blade roots
OL 72-144			Applicable Engine - Combustion Chamber - Introduction of vaporizers with magnesium zirconate coating
OL 72-144	01		Applicable Engine - Combustion Chamber - Introduction of vaporizers with magnesium zirconate coating
OL 72-145			Applicable Engine - HP and LP turbine rotor disks - Introduction of eddy-current inspection
OL 72-145	01		Applicable Engine - HP and LP turbine rotor disks - Introduction of eddy-current inspection
OL 72-145	02		Applicable Engine - HP and LP turbine rotor disks - Introduction of eddy-current inspection
OL 72-145	03		Applicable Engine - HP and LP turbine rotor disks - Introduction of eddy-current inspection

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	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-145	04		Applicable Engine - HP and LP turbine rotor disks - Introduction of eddy-current inspection
R	OL 72-145	05		Not Applicable Engine - HP and LP turbine rotor disks - Introduction of eddy-current inspection
	OL 72-146			Applicable Engine/Oil - Oil tubes - Intermediate case - Introduction of restrictor in oil supply to LP and HP thrust bearings/lower oil differential switch setting
	OL 72-146	01		Applicable Engine/Oil - Oil tubes - Intermediate case - Introduction of restrictor in oil supply to LP and HP thrust bearings/lower oil differential switch setting
	OL 72-146	02		Applicable Engine/Oil - Oil tubes - Intermediate case - Introduction of restrictor in oil supply to LP and HP thrust bearings/lower oil differential switch setting
	OL 72-146	03		Applicable Engine/Oil - Oil tubes - Intermediate case - Introduction of restrictor in oil supply to LP and HP thrust bearings/lower oil differential switch setting
	OL 72-146	04		Applicable Engine/Oil - Oil tubes - Intermediate case - Introduction of restrictor in oil supply to LP and HP thrust bearings/lower oil differential switch setting
	OL 72-147			Applicable Engine - Base module - Inspection for failure of locking plates (No.12 labyrinth seal) and introduction of new locking plates

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-147	01		Applicable Engine - Base module - Inspection for failure of locking places (No.12 labyrinth seal) and introduction of new locking plates
OL 72-147	02		Applicable Engine - Base module - Inspection for failure of locking places (No.12 labyrinth seal) and introduction of new locking plates
OL 72-148			Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
OL 72-148	01		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
OL 72-148	02		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
OL 72-148	03		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
OL 72-148	04		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
OL 72-148	05		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-148	06		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
OL 72-148	07		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
OL 72-148	08		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
R OL 72-148	09		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
OL 72-149			Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
OL 72-149	01		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
OL 72-149	02		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
OL 72-149	03		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-149	04		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
OL 72-149	05		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
OL 72-149	06		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
R OL 72-149	07		Applicable Engine HP compressor rotor - Introduction of stage 1 rotor blades having preferential pitch on the blade root serrations
OL 72-150			Embodied Engine - Spherical flange adaptor - Improvement in maintenance and reliability of seal cover
OL 72-150	01		Applicable Engine - Spherical flange adaptor - Improvement in maintenance and reliability of seal cover
OL 72-150	02		Applicable Engine - Spherical flange adaptor - Improvement in maintenance and reliability of seal cover
OL 72-151			Applicable Engine - Air intake case - Revised outer web fillet radii/introduction of modified air flow restrictor plates
OL 72-152			Applicable Engine - Turbine exhaust diffuser assembly - Introduction of new diffuser outer case
OL 72-153			Applicable Engine - HP and LP compressor case and vanes - Introduction of longer bolts

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-154			Applicable Engine - HP compressor rotor - New No. 12 labyrinth
OL 72-154	01		Applicable Engine - HP compressor rotor - New No. 12 labyrinth
OL 72-154	02		Applicable Engine - HP compressor rotor - New No. 12 labyrinth
OL 72-155			Applicable Engine - Base module/HP turbine hub assy - Inspection for cracking in hirth serrations
OL 72-155	01		Applicable Engine - Base module/HP turbine hub assy - Inspection for cracking in hirth serrations
R OL 72-155			CANCELLED
OL 72-156			Applicable Engine - LP turbine rotor - Introduction of improved locking tab
OL 72-157			Applicable Engine - HP compressor diffuser case assembly - Modified stepped pins
OL 72-158			Applicable Engine - Combustion chamber outer case (non-modular) - Support tube with re-designed mounting lug
OL 72-159			Applicable Engine - HP compressor rotor - Modified blade locking plates
OL 72-160			Applicable Engine - HP compressor rotor - Introduction of plasma sprayed air transfer tube assembly
OL 72-161			Applicable Engine - LH and RH accessory gearbox assemblies - Introduction of new coupling ring bolts
OL 72-162			Applicable Engine - LP turbine rotor - Introduction of alternative disks

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-163			Applicable Engine - HP turbine rotor - Inspection and annealing of the turbine blade locking plates
R	OL 72-163	01		Applicable Engine - HP turbine rotor - Inspection and annealing of the turbine blade locking plates
	OL 72-164			Applicable Engine - HP turbine rotor - Introduction of HP turbine rotor blades with improved creep characteristics
	OL 72-165			Applicable Engine - LP compressor rotor - Vapour blasting of front rotor shaft
	OL 72-165	01		Applicable Engine - LP compressor rotor - Vapour blasting of front rotor shaft
R	OL 72-165	02		Applicable Engine - LP compressor rotor - Vapour blasting of front rotor shaft
	OL 72-166			Applicable Engine - Accessory gearbox case assembly LH/main drives accessory gearbox LH/fuel control unit drive and main oil pump drive - new bearing oil jet assembly and LH accessory gearbox case assembly
R	OL 72-166	01		Applicable Engine - Accessory gearbox case assembly LH/main drives accessory gearbox LH/fuel control unit drive and main oil pump drive - new bearing oil jet assembly and LH accessory gearbox case assembly
R	OL 72-166	02		Applicable Engine - Accessory gearbox case assembly LH/main drives accessory gearbox LH/fuel control unit drive and main oil pump drive - new bearing oil jet assembly and LH accessory gearbox case assembly

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-167			Applicable Engine - HP compressor rotor - Intro - duction of front rotor shaft and stage 1 HP compressor rotor disk manufactured in revised material
OL 72-167	01		Applicable Engine - HP compressor rotor - Intro - duction of front rotor shaft and stage 1 HP compressor rotor disk manufactured in revised material
OL 72-167	02		Applicable Engine - HP compressor rotor - Intro - duction of front rotor shaft and stage 1 HP compressor rotor disk manufactured in revised material
OL 72-167	03		Applicable Engine - HP compressor rotor - Intro - duction of front rotor shaft and stage 1 HP compressor rotor disk manufactured in revised material
OL 72-168			Applicable Engine - Accessory gearbox case assembly LH - Repositioned identification plate (module)
OL 72-169			Applicable Engine - HP turbine nozzle - Additional vane cooling holes
OL 72-169	01		Applicable Engine - HP turbine nozzle - Additional vane cooling holes
OL 72-169	02		Applicable Engine - HP turbine nozzle - Additional vane cooling holes
R OL 72-169	03		Applicable Engine - HP turbine nozzle - Additional vane cooling holes
OL 72-170			Applicable Engine - Combustion chamber outer case (CCOC) - Introduction of longer mounting trunnion securing bolts to meet current design standards

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-171			Applicable Engine - Main standby hydraulic pumps drives - Introduction of a new oil seal
	OL 72-172			Applicable Engine - HP compressor rotor - Introduction of longer bolts
	OL 72-173			Applicable Engine - Combustion chamber outer case (CCOC) attaching parts - Introduction of new bolts
	OL 72-174			Applicable Engine - HP turbine rotor - New No.23 labyrinth assembly
	OL 72-175			Applicable Engine - LP compressor rotor - Vapour blasting of Group A components
	OL 72-175	01		Applicable Engine - LP compressor rotor - Vapour blasting of Group A components
R	OL 72-175	02		Applicable Engine - LP compressor rotor - Vapour blasting of Group A components
R	OL 72-175	03		Applicable Engine - LP compressor rotor - Vapour blasting of Group A components
	OL 72-176			Applicable Engine - Turbine exhaust diffuser - New containment shield bolts
	OL 72-176	01		Applicable Engine - Turbine exhaust diffuser - New containment shield bolts
R	OL 72-176	02		Applicable Engine - Turbine exhaust diffuser - New containment shield bolts
	OL 72-177			Applicable Engine - HP turbine rotor - Alternative blades
	OL 72-178			Applicable Engine - Combustion chamber outer case (CCOC) - Introduction of new cases

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-179			Applicable Engine - Combustion chamber outer case (CCOC) - New combustion chamber outer case (CCOC)
OL 72-179	01		Applicable Engine - Combustion chamber outer case (CCOC) - New combustion chamber outer case (CCOC)
OL 72-180			Applicable Engine - LP turbine bearing support - Improved transfer block (oil) location
OL 72-181			Applicable Engine - Turbine exhaust diffuser assembly - Introduction of modified inner case assembly
R OL 72-181	01		Applicable Engine - Turbine exhaust diffuser assembly - Introduction of modified inner case assembly
OL 72-182			Applicable Engine - Pulse probe and housing - Inspection of the pulse probe drive splined shaft
OL 72-182	01		Applicable Engine - Pulse probe and housing - Inspection of the pulse probe drive splined shaft
OL 72-183			Applicable Engine - Compressor intermediate case - Improved sealing of oil sump drain tube
OL 72-183	01		Applicable Engine - Compressor intermediate case - Improved sealing of oil sump drain tube
OL 72-183	02		Applicable Engine - Compressor intermediate case - Improved sealing of oil sump drain tube
OL 72-184			Applicable Engine - Compressor intermediate case - Introduction of new drain tube assembly
OL 72-185			Applicable Engine - LP turbine nozzles - Modified nozzle vane support diaphragm assembly

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-185	01		Applicable Engine - LP turbine nozzles - Modified nozzle vane support diaphragm assembly
R	OL 72-185	02		Applicable Engine - LP turbine nozzles - Modified nozzle vane support diaphragm assembly
	OL 72-186			Applicable Engine - Compressor intermediate case assembly - Bearing failure warning tube - Modified tube and gland nut
	OL 72-186	01		Applicable Engine - Compressor intermediate case assembly - Bearing failure warning tube - Modified tube and gland nut
	OL 72-187			Applicable Engine - Compressor intermediate case assembly - Silver plating of inner segment bolt-holes
	OL 72-188			Applicable Engine - LH accessory gearbox/oil scavenge pumps - Improved oil scavenging in LH accessory gearbox and intermediate case assemblies
	OL 72-188	01		Applicable Engine - LH accessory gearbox/oil scavenge pumps - Improved oil scavenging in LH accessory gearbox and intermediate case assemblies
	OL 72-188	02		Applicable Engine - LH accessory gearbox/oil scavenge pumps - Improved oil scavenging in LH accessory gearbox and intermediate case assemblies
	OL 72-188	03		Applicable Engine - LH accessory gearbox/oil scavenge pumps - Improved oil scavenging in LH accessory gearbox and intermediate case assemblies
	OL 72-188	04		Applicable Engine - LH accessory gearbox/oil scavenge pumps - Improved oil scavenging in LH accessory gearbox and intermediate case assemblies

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-188	05		Applicable Engine - LH accessory gearbox/oil scavenge pumps - Improved oil scavenging in LH accessory gearbox and intermediate case assemblies
R	OL 72-188	06		Applicable Engine - LH accessory gearbox/oil scavenge pumps - Improved oil scavenging in LH accessory gearbox and intermediate case assemblies
	OL 72-189			Applicable Engine - Accessory gearbox case assembly RH - Introduction of toroidal sealing rings at pressure and scavenge oil filters
	OL 72-190			Applicable Engine - Main oil pump - New scavenge oil pump case LP compressor front bearing
	OL 72-191			Applicable Engine - LP compressor rotor - Intro-duction of longer bolts - Various locations
	OL 72-191	01		Applicable Engine - LP compressor rotor - Intro-duction of longer bolts - Various locations
	OL 72-192			Applicable Engine - Case diffuser compressor HP - Deletion of alternative standard of blanking covers
	OL 72-193			Applicable Engine - Accessory gearbox case assembly LH - Inspection of magnetic plug for bearing failure
	OL 72-193	01		Applicable Engine - Accessory gearbox case assembly LH - Inspection of magnetic plug for bearing failure
R	OL 72-193			CANCELLED
	OL 72-194			Applicable Engine - Turbine exhaust diffuser - Modified LP turbine oil bearing scavenge tube assembly

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-195			Applicable Engine - Air intake fairing - Dee headed bolts and nuts
OL 72-195	01		Applicable Engine - Air intake fairing - Dee headed bolts and nuts
OL 72-196			Applicable Engine - Conversion engine data
R OL 72-196	01		Applicable Engine - Conversion engine data
OL 72-197			Applicable Engine - Intermediate compressor case - Adapter assembly pin holes enlarged
OL 72-198			Applicable Engine - High pressure compressor diffuser case - Introduction of modified air tube assembly with revised insulation and clipping
OL 72-199			Applicable Engine - HP compressor diffuser case assembly - Introduction of longer insulation blanket clips
OL 72-200			Applicable Engine - HP compressor diffuser case assembly - Introduction of improved clips for insulation blanket on tubes serving the HP turbine bearing
OL 72-200	01		Applicable Engine - HP compressor diffuser case assembly - Introduction of improved clips for insulation blanket on tubes serving the HP turbine bearing
R OL 72-200	02		Applicable Engine - HP compressor diffuser case assembly - Introduction of improved clips for insulation blanket on tubes serving the HP turbine bearing
OL 72-201			Applicable Engine - LP compressor rotor - Revised material specification

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-202			Applicable Engine - LP compressor rotor - Introduction of shot peening to disks and blades stages 2-7
OL 72-202	01		Applicable Engine - LP compressor rotor - Introduction of shot peening to disks and blades stages 2-7
OL 72-202	02		Applicable Engine - LP compressor rotor - Introduction of shot peening to disks and blades stages 2-7
OL 72-202	03		Applicable Engine - LP compressor rotor - Introduction of shot peening to disks and blades stages 2-7
OL 72-202	04		Applicable Engine - LP compressor rotor - Introduction of shot peening to disks and blades stages 2-7
OL 72-202	05		Applicable Engine - LP compressor rotor - Introduction of shot peening to disks and blades stages 2-7
OL 72-202	06		Applicable Engine - LP compressor rotor - Introduction of shot peening to disks and blades stages 2-7
OL 72-202	07		Applicable Engine - LP compressor rotor - Introduction of shot peening to disks and blades stages 2-7
OL 72-202	08		Applicable Engine - LP compressor rotor - Introduction of shot peening to disks and blades stages 2-7
OL 72-202	09		Applicable Engine - LP compressor rotor - Introduction of shot peening to disks and blades stages 2-7

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-203			Applicable Engine - Main drives accessory gearbox LH - Inspection of Zerol bevel gear assembly
R	OL 72-203	01		Applicable Engine - Main drives accessory gearbox LH - Inspection of Zerol bevel gear assembly
	OL 72-204			Applicable Engine - HP compressor rotor - Inspection of stage 5-6 spacer ring
R	OL 72-204			CANCELLED
	OL 72-205			Applicable Engine - Compressor intermediate case assembly - Introduction of new bolts
	OL 72-206			Applicable Engine - Combustion chamber outer case (CCOC) - Inspection/Check - Check to determine the integrity of the bolts securing the nozzle vane abutment segments
	OL 72-206	01		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection/Check - Check to determine the integrity of the bolts securing the nozzle vane abutment segments
	OL 72-206	02		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection/Check - Check to determine the integrity of the bolts securing the nozzle vane abutment segments
	OL 72-206	03		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection/Check - Check to determine the integrity of the bolts securing the nozzle vane abutment segments

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-206	04		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection/Check - Check to determine the integrity of the bolts securing the nozzle vane abutment segments
OL 72-206	05		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection/Check - Check to determine the integrity of the bolts securing the nozzle vane abutment segments
OL 72-207			Applicable Engine - Turbine support bearing - LP turbine nozzle - HP turbine nozzle - New bolt retaining rings
OL 72-208			Applicable Engine - HP compressor rotor - Inspection of stage 1 rotor blade roots
OL 72-208	01		Applicable Engine - HP compressor rotor - Inspection of stage 1 rotor blade roots
OL 72-208	02		Applicable Engine - HP compressor rotor - Inspection of stage 1 rotor blade roots
OL 72-209			Applicable Engine - HP turbine bearing support - Deletion of inner duct
OL 72-209	01		Applicable Engine - HP turbine bearing support - Deletion of inner duct
OL 72-209	02		Applicable Engine - HP turbine bearing support - Deletion of inner duct
OL 72-210			Applicable Engine - Compressor intermediate case - Introduction of compressor intermediate case with cusps at vane ends removed
OL 72-211			Applicable Engine - HP compressor case and vanes - Improved intrascope port blanking plugs

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-213			Applicable Engine - HP compressor diffuser case - Inspection of No. 12 labyrinth seal countersunk head screws
OL 72-214			Applicable Engine - HP turbine rotor - Introduction of new thrust washer
OL 72-214	01		Applicable Engine - HP turbine rotor - Introduction of new thrust washer
OL 72-214	02		Applicable Engine - HP turbine rotor - Introduction of new thrust washer
OL 72-215			Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of bolts securing vane locking pins or extended head pins and/or pin
OL 72-215	01		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of bolts securing vane locking pins or extended head pins and/or pin
OL 72-215	02		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of bolts securing vane locking pins or extended head pins and/or pin
R OL 72-215	03		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of bolts securing vane locking pins or extended head pins and/or pin
R OL 72-215	04		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of bolts securing vane locking pins or extended head pins and/or pin
OL 72-216			Applicable Engine - LP turbine nozzle vane support diaphragm - Introduction of blanking plates

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-217			Applicable Engine - LP compressor case and vanes - Flame plated abutment faces of stage 2 LP compressor vanes
OL 72-217	01		Applicable Engine - LP compressor case and vanes - Flame plated abutment faces of stage 2 LP compressor vanes
OL 72-218			Applicable Engine - LP turbine - Revised LP turbine bearing oil feed, return and cold vent tubes
OL 72-218	01		Applicable Engine - LP turbine - Revised LP turbine bearing oil feed, return and cold vent tubes
OL 72-218	02		Applicable Engine - LP turbine - Revised LP turbine bearing oil feed, return and cold vent tubes
OL 72-218	03		Applicable Engine - LP turbine - Revised LP turbine bearing oil feed, return and cold vent tubes
OL 72-218	04		Applicable Engine - LP turbine - Revised LP turbine bearing oil feed, return and cold vent tubes
OL 72-218	05		Applicable Engine - LP turbine - Revised LP turbine bearing oil feed, return and cold vent tubes
OL 72-219			Applicable Engine - Compressor intermediate case assembly/LP compressor rotor - Aluminium enamelled parts
OL 72-220			Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of CCOC longitudinal weld and igniter/primary fuel sprayer boss weld

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-220	01		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of CCOC longitudinal weld and igniter/primary fuel sprayer boss weld
OL 72-220	02		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of CCOC longitudinal weld and igniter/primary fuel sprayer boss weld
OL 72-220	03		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of CCOC longitudinal weld and igniter/primary fuel sprayer boss weld
OL 72-220	04		Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of CCOC longitudinal weld and igniter/primary fuel sprayer boss weld
OL 72-220	05		Not Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of CCOC longitudinal weld and igniter/primary fuel sprayer boss weld
OL 72-221			Applicable Engine - HP compressor diffuser case - Introduction of new No.12 labyrinth seal countersunk head screws
OL 72-222			Applicable Engine - HP turbine bearing support - Introduction of antifretting treatment
OL 72-222	01		Applicable Engine - HP turbine bearing support - Introduction of antifretting treatment
OL 72-223			Applicable Engine - LP compressor rotor - Introduction of stages 2 and 3 HP compressor blades having preferential pitch on the blade root serrations

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-223	01		Applicable Engine - LP compressor rotor - Introduction of stages 2 and 3 HP compressor blades having preferential pitch on the blade root serrations
OL 72-223	02		Applicable Engine - LP compressor rotor - Introduction of stages 2 and 3 HP compressor blades having preferential pitch on the blade root serrations
OL 72-223	03		Applicable Engine - LP compressor rotor - Introduction of stages 2 and 3 HP compressor blades having preferential pitch on the blade root serrations
OL 72-224			Applicable Engine - RH accessory gearbox case - Inspection check of coupling ring assembly

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SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-224	01		Applicable Engine - RH accessory gearbox case - Inspection check of coupling ring assembly
OL 72-224	02		Applicable Engine - RH accessory gearbox case - Inspection check of coupling ring assembly
OL 72-225			Applicable Engine - LP and HP rotors - Introduction of longer bolts at disc to hub and balancing positions
OL 72-226			Applicable Engine - Main oil pump - Modified inner strainer assemblies
OL 72-227			Applicable Engine - Nozzle LP - Revised brazing procedure for thermocouple guide tubes
OL 72-227	01		Applicable Engine - Nozzle LP - Revised brazing procedure for thermocouple guide tubes
OL 72-228			Applicable Engine - LP turbine nozzle vane assembly - Reduced radial thickness of the front locating lug
OL 72-229			Applicable Engine - LH accessory gearbox - FCU drive gearshaft load spreading washer
OL 72-230			Applicable Engine - LP compressor front drive shaft - Introduction of modified LP compressor front drive shaft drive splines
OL 72-230	01		Applicable Engine - LP compressor front drive shaft - Introduction of modified LP compressor front drive shaft drive splines
OL 72-230	02		Applicable Engine - LP compressor front drive shaft - Introduction of modified LP compressor front drive shaft drive splines

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-230	03		Applicable Engine - LP compressor front drive shaft - Introduction of modified LP compressor front drive shaft drive splines
OL 72-230	04		Applicable Engine - LP compressor front drive shaft - Introduction of modified LP compressor front drive shaft drive splines
R OL 72-230	05		Applicable Engine - LP compressor front drive shaft - Introduction of modified LP compressor front drive shaft drive splines
OL 72-231			Applicable Engine - LP turbine nozzle vane assembly - Deletion of vent hole from vane profile
OL 72-232			Applicable Engine - Fuel system components lifting equipment support bracket - Shorter securing bolts
OL 72-233			Applicable Engine - HP turbine hub assembly - Inspection for cracking in Hirth serrations
OL 72-233	01		Applicable Engine - HP turbine hub assembly - Inspection for cracking in Hirth serrations
OL 72-233			CANCELLED
OL 72-234			Applicable Engine - LP compressor exit guide case and vanes modular attachment - Longer bolts
OL 72-235			Applicable Engine - LP compressor case and vanes - Introduction of LP compressor vanes with increased thickness of flame plating
OL 72-235	01		Applicable Engine - LP compressor case and vanes - Introduction of LP compressor vanes with increased thickness of flame plating

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-235	02		Applicable Engine - LP compressor case and vanes - Introduction of LP compressor vanes with increased thickness of flame plating

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SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-235	03		Applicable Engine - LP compressor case and vanes - Introduction of LP compressor vanes with increased thickness of flame plating
OL 72-236			Applicable Engine - Integrated drive generator and fuel system component lifting brackets - Introduction of proof testing
OL 72-236	01		Applicable Engine - Integrated drive generator and fuel system component lifting brackets - Introduction of proof testing
OL 72-237			Applicable Engine - Internal accessory drives - Inspection of Zerol bevel gearshaft part No. B.431036
OL 72-238			Applicable Engine - LP compressor case and vanes - Introduction of modified LP and HP compressor thrust bearing oil feed tube bracket
OL 72-239			Applicable Engine - Turbine exhaust diffuser assembly - Alternative exhaust diffuser-inner
OL 72-240			Applicable Engine - LP and HP turbine hub assemblies - Inspection of hubs
OL 72-240	01		Applicable Engine - LP and HP turbine hub assemblies - Inspection of hubs
OL 72-240	02		Applicable Engine - LP and HP turbine hub assemblies - Inspection of hubs
OL 72-240	03		Applicable Engine - LP and HP turbine hub assemblies - Inspection of hubs
OL 72-240	04		Applicable Engine - LP and HP turbine hub assemblies - Inspection of hubs

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-241			Applicable Engine - Compressor intermediate case - Internal accessory drives - LP tacho drive housing and housing support - Modified tube oil sump and balanced pulse probe drive splined shaft
OL 72-242			Applicable Engine - HP and LP turbine rotor disks - Rig spinning with eddy current and fluorescent dye penetrant inspection
OL 72-242	01		Applicable Engine - HP and LP turbine rotor disks - Rig spinning with eddy current and fluorescent dye penetrant inspection
R OL 72-242	02		Applicable Engine - HP and LP turbine rotor disks - Rig spinning with eddy current and fluorescent dye penetrant inspection
R OL 72-242	03		Applicable Engine - HP and LP turbine rotor disks - Rig spinning with eddy current and fluorescent dye penetrant inspection
OL 72-243			Applicable Engine - Internal accessory drives - LP tacho drive support bearing with improved material specification
OL 72-244			Applicable Engine - HP turbine assembly - Introduction of an outer air duct assembly incorporating a stiffening ring
OL 72-244	01		Applicable Engine - HP turbine assembly - Introduction of an outer air duct assembly incorporating a stiffening ring
R OL 72-244	02		Applicable Engine - HP turbine assembly - Introduction of an outer air duct assembly incorporating a stiffening ring
OL 72-245			Applicable Engine - Compressor intermediate case assembly - Introduction of spacing washers on combined air vent drain tube lug

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-246			Applicable Engine - Accessory drives/LH accessory gearbox assembly - Introduction of new accessory gearbox case assembly, bevel gear and oil pump drive gear bearings
OL 72-246	01		Applicable Engine - Accessory drives/LH accessory gearbox assembly - Introduction of new accessory gearbox case assembly, bevel gear and oil pump drive gear bearings
OL 72-246	02		Applicable Engine - Accessory drives/LH accessory gearbox assembly - Introduction of new accessory gearbox case assembly, bevel gear and oil pump drive gear bearings
OL 72-246	03		Applicable Engine - Accessory drives/LH accessory gearbox assembly - Introduction of new accessory gearbox case assembly, bevel gear and oil pump drive gear bearings
R OL 72-246	04		Applicable Engine - Accessory drives/LH accessory gearbox assembly - Introduction of new accessory gearbox case assembly, bevel gear and oil pump drive gear bearings
R OL 72-246	05		Applicable Engine - Accessory drives/LH accessory gearbox assembly - Introduction of new accessory gearbox case assembly, bevel gear and oil pump drive gear bearings
OL 72-247			Applicable Engine - Intermediate compressor case assembly - Modified LP thrust and HP thrust bearing adjusting oil throwers
OL 72-248			Applicable Engine - Combustion chamber outer case (CCOC) - Change of material for bolts attaching nozzle vane abutment segments
OL 72-248	01		Applicable Engine - Combustion chamber outer case (CCOC) - Change of material for bolts attaching nozzle vane abutment segments

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-248	02		Applicable Engine - Combustion chamber outer case (CCOC) - Change of material for bolts attaching nozzle vane abutment segments
OL 72-249			Applicable Engine - Intermediate compressor case assembly - Revised hollow pin for locating RH accessory gearbox mounting assembly
OL 72-250			Applicable Engine - Base module - Inspection of HP turbine bearing oil feed, scavenge and air venting insulated tube assemblies at or before 4000 hours
OL 72-250	01		Applicable Engine - Base module - Inspection of HP turbine bearing oil feed, scavenge and air venting insulated tube assemblies at or before 4000 hours
OL 72-251			Applicable Engine/Engine fuel and Control/Oil - Various tube assemblies - Inspection of all external rigid fuel and oil tube assemblies at their clamp loop positions
OL 72-251	01		Applicable Engine/Engine fuel and Control/Oil - Various tube assemblies - Inspection of all external rigid fuel and oil tube assemblies at their clamp loop positions
OL 72-252			Applicable Engine - HP compressor stator vanes stages 1 and 2 - Increased plating thickness
OL 72-252	01		Applicable Engine - HP compressor stator vanes stages 1 and 2 - Increased plating thickness
OL 72-252	02		Applicable Engine - HP compressor stator vanes stages 1 and 2 - Increased plating thickness

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
R OL 72-252	03		Applicable Engine - HP compressor stator vanes stages 1 and 2 - Increased plating thickness
R OL 72-252	04		Applicable Engine - HP compressor stator vanes stages 1 and 2 - Increased plating thickness
R OL 72-252	05		Applicable Engine - HP compressor stator vanes stages 1 and 2 - Increased plating thickness
OL 72-253			Applicable Engine - Introduction of shortened HP compressor rotor blades at stages 4, 5, 6 and 7
OL 72-254			Applicable Engine - LP turbine rotor assy - Reduction in cyclic life of LP turbine hub assy part number B.922662 or B.922296 (Group A part) from 2100 to 1800 flight cycles
OL 72-254	01		Not applicable
R OL 72-254			CANCELLED
OL 72-255			Applicable Engine - HP compressor rotor - Inspection of stage 7 rotor disk at or before 1200 flight cycles
R OL 72-255			CANCELLED
OL 72-256			Applicable Engine - Combustion chamber outer case (CCOC) Intrascope blanking cover - shorter securing bolts
OL 72-257			Applicable Engine - LP compressor rotor - Stage 1 rotor blades - Shot peening of blade root and aerofoil surfaces
OL 72-257	01		Applicable Engine - LP compressor rotor - Stage 1 rotor blades - Shot peening of blade root and aerofoil surfaces

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-257	02		Applicable Engine - LP compressor rotor - Stage 1 rotor blades - Shot peening of blade root and aerofoil surfaces
	OL 72-257	03		Applicable Engine - LP compressor rotor - Stage 1 rotor blades - Shot peening of blade root and aerofoil surfaces
	OL 72-258			Applicable Engine - HP compressor case - Introduction of additional probe access hole in rear casing
	OL 72-259			Applicable Engine - Combustion chamber - Improved combustion chamber and shroudless vaporisers
	OL 72-259	01		Applicable Engine - Combustion chamber - Improved combustion chamber and shroudless vaporisers
R	OL 72-259			CANCELLED
	OL 72-260			Applicable Engine - HP turbine rotor - Introduction of HP turbine blade assembly with reinforced bridge pieces
R	OL 72-260	01		Applicable Engine - HP turbine rotor - Introduction of HP turbine blade assembly with reinforced bridge pieces
	OL 72-261			Applicable Engine - Combustion chamber outer case - Introduction of alternative standard
	OL 72-262			Applicable Engine - Various - Introduction of new corruplus seals in the air intake case right and left hand accessory gearboxes main drives oil pump air and oil tube assemblies
	OL 72-263			Applicable Engine - Combustion chamber - Intrascope inspection of combustion chambers

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-263	01		Applicable Engine - Combustion chamber - Intrascope inspection of combustion chambers
R OL 72-263	02		Applicable Engine - Combustion chamber - Intrascope inspection of combustion chambers
R OL 72-263	03		Applicable Engine - Combustion chamber - Intrascope inspection of combustion chambers
OL 72-264			Applicable Engine - Combustion chamber - Improved combustion chamber with reduced skirt gap on number 2 inner and outer blown cooling rings
R OL 72-264			CANCELLED
OL 72-265			Applicable Engine - Air intake case - Instrumented cases modified to latest design
OL 72-266			Applicable Engine - HP compressor diffuser case assembly - Inspection of diffuser case assembly damping ring B.395697 for rotation at overhaul/repair
R OL 72-266	01		Applicable Engine - HP compressor diffuser case assembly - Inspection of diffuser case assembly damping ring B.395697 for rotation at overhaul/repair
OL 72-267			Applicable Engine - Compressor intermediate case assembly - Internal accessory drives - Introduction of abradable coating on labyrinth housing 3-10
OL 72-267	01		Applicable Engine - Compressor intermediate case assembly - Internal accessory drives - Introduction of abradable coating on labyrinth housing 3-10
OL 72-267	02		Applicable Engine - Compressor intermediate case assembly - Internal accessory drives - Introduction of abradable coating on labyrinth housing 3-10

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-267	03		Applicable Engine - Compressor intermediate case assembly - Internal accessory drives - Introduction of abradable coating on labyrinth housing 3-10
	OL 72-267	04		Applicable Engine - Compressor intermediate case assembly - Internal accessory drives - Introduction of abradable coating on labyrinth housing 3-10
R	OL 72-267	05		Applicable Engine - Compressor intermediate case assembly - Internal accessory drives - Introduction of abradable coating on labyrinth housing 3-10
	OL 72-268			Applicable Engine - LP compressor rotor - Intro-duction of shot peened 1st stage rotor disk blade slots
R	OL 72-268	01		Applicable Engine - LP compressor rotor - Intro-duction of shot peened 1st stage rotor disk blade slots
	OL 72-269			Applicable Engine - Combustion chamber outer case (CCOC) - Introduction of retention brackets for bolts attaching nozzle vane abutment segments
	OL 72-270			Applicable Engine - Front bearing oil feed and improved fastenings for duct, air, scavenge tubes - Thicker inner flange and material change
	OL 72-271			Applicable Engine - HP turbine assembly - Inspection of HP turbine bearing inner and outer duct front mounting
R	OL 72-272			Not Applicable Engine - RH accessory gearbox - Bolted flange at main coupling
R	OL 72-272	01		Not Applicable Engine - RH accessory gearbox - Bolted flange at main coupling

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-272	02		Not Applicable Engine - RH accessory gearbox - Bolted flange at main coupling
OL 72-273			Not Applicable Miscellaneous -Introduction of group service bulletin for record purposes only
OL 72-273	01		Not Applicable Miscellaneous -Introduction of group service bulletin for record purposes only
R OL 72-276			Not applicable Engine - Combustion Chamber Outer Case - Introduction of alternative standard
R OL 72-276	01		Not applicable Engine - Combustion Chamber Outer Case - Introduction of alternative standard
OL 72-279			Applicable Engine - HP compressor assembly - Reduction in cyclic life of stages 3, 4, 6 and 7 rotor disks, 5 - 6 stage spacer ring, HP rotor shaft front and HP drive shaft (Group A parts)
OL 72-279	01		Not Applicable
OL 72-279			CANCELLED
OL 72-280			Applicable Engine - Combustion chamber outer case (CCOC) - Introduction of nozzle vane abutment segment retaining bolts with reduced waist diameter
OL 72-281			Applicable Engine - HP turbine rotor - Introduction of alternative standard of HP turbine blade assembly
OL 72-281			CANCELLED
OL 72-282			Applicable Engine - Combustion chamber - Improved combustion chamber incorporating shroudless vaporisers
OL 72-282	01		Applicable Engine - Combustion chamber - Improved combustion chamber incorporating shroudless vaporisers

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-282	02		Applicable Engine - Combustion chamber - Improved combustion chamber incorporating shroudless vaporisers
OL 72-283			Applicable Engine - Combustion chamber outer case (CCOC) - Introduction of pairs of brackets to retain CCOC bolts in the event of failure
OL 72-284			Applicable Engine - Air intake fairing - Introduction of damper spring on inner skin of fairing
OL 72-284	01		Applicable Engine - Air intake fairing - Introduction of damper spring on inner skin of fairing
OL 72-284	02		Applicable Engine - Air intake fairing - Introduction of damper spring on inner skin of fairing
OL 72-285			Applicable Engine - Internal accessory drives - Change of material for RH and LH gearbox drive Zerol bevel gears
OL 72-286			Applicable Engine - Internal accessory drives - RH gearbox Zerol bevel gearshaft damping plate
OL 72-286	01		Applicable Engine - Internal accessory drives - RH gearbox Zerol bevel gearshaft damping plate
OL 72-286	02		Applicable Engine - Internal accessory drives - RH gearbox Zerol bevel gearshaft damping plate
OL 72-286	03		Applicable Engine - Internal accessory drives - RH gearbox Zerol bevel gearshaft damping plate

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-286	04		Applicable Engine - Internal accessory drives - RH gearbox Zerol bevel gearshaft damping plate

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SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-287			Applicable Engine - HP compressor diffuser case assembly - Introduction of a modified diffuser case assembly incorporating a damping ring with increased interference fit
OL 72-287	01		Applicable Engine - HP compressor diffuser case assembly - Introduction of a modified diffuser case assembly incorporating a damping ring with increased interference fit
OL 72-287	02		Applicable Engine - HP compressor diffuser case assembly - Introduction of a modified diffuser case assembly incorporating a damping ring with increased interference fit
OL 72-288			Applicable
R OL 72-288			CANCELLED
OL 72-289			Applicable Engine - Combustion chamber - Life limitation imposed on vaporisers in certain combustion chambers
OL 72-290			Applicable Engine - HP compressor rotor - Stage 7 disk with a supply of hot air to the bore
R OL 72-290			CANCELLED
OL 72-291			Not Applicable
OL 72-292			Applicable Engine - Air intake case - Cancellation of smaller diameter vibrometer cable guide tube
R OL 72-293			Not Applicable Engine - LP compressor rotor rear shaft assembly - Extension of existing aluminium enamelled areas
R OL 72-293	01		Not Applicable Engine - LP compressor rotor rear shaft assembly - Extension of existing aluminium enamelled areas

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-294			Applicable Engine - LP compressor/HP compressor - Reduction in cyclic life of certain LP compressor disks stages 1 to 4, 6 and 7 and HP compressor disk stage 1 (group A parts)
R	OL 72-294	01		Applicable Engine - LP compressor/HP compressor - Reduction in cyclic life of certain LP compressor disks stages 1 to 4, 6 and 7 and HP compressor disk stage 1 (group A parts)
R	OL 72-294	02		Applicable Engine - LP compressor/HP compressor - Reduction in cyclic life of certain LP compressor disks stages 1 to 4, 6 and 7 and HP compressor disk stage 1 (group A parts)
	OL 72-296	04	Sep 30/94	Embodied Engine - LP compressor stage 1 stator vane - Introduction of anti-fret liners to stage 1 inner fixing ring grooves
	OL 72-297	03	Sep 30/94	Embodied Engine - HP compressor case and vanes - Anti-fret liners in 1st and 2nd stage HP compressor vane inner fixing rings
	OL 72-298	03	Sep 20/94	Embodied Engine - LP compressor case and vanes - Introduction of anti-fret liners to stages 2 to 6 inner fixing rings
R	OL 72-299			Not Applicable Engine - HP turbine assembly - Outer air duct assembly with flame plated spigot
R	OL 72-299	01		Not Applicable Engine - HP turbine assembly - Outer air duct assembly with flame plated spigot
R	OL 72-300			Applicable Engine - LP compressor rotor - Improved inspection for LP compressor blade stage 1

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-300	01		Applicable Engine - LP compressor rotor - Improved inspection for LP compressor blade stage 1
OL 72-300	02		Applicable Engine - LP compressor rotor - Improved inspection for LP compressor blade stage 1
OL 72-301			Not Applicable Engine - LP compressor rotor - Inspection of stage 1 LP compressor blade
OL 72-302			Not Applicable Engine - HP compressor rotor - Frequency check for 2nd stage HP compressor rotor blades
OL 72-302	01		Not Applicable Engine - HP compressor rotor - Frequency check for 2nd stage HP compressor rotor blades
OL 72-303			Not Applicable Engine - LP turbine rotor - Increased clearance between No. 26 labyrinth housing and LP turbine rotor disk
OL 72-304	02		Applicable Engine - Combustion chamber - Inspection frequencies
OL 72-304	03		Applicable Engine - Combustion chamber - Inspection frequencies
OL 72-304	04		Applicable Engine - Combustion chamber - Inspection frequencies
OL 72-305			Applicable Engine - HP compressor exit guide vanes - Vane retaining bolt replacement
OL 72-305	01		Applicable Engine - HP compressor exit guide vanes - Vane retaining bolt replacement
R OL 72-305	02		Applicable Engine - HP compressor exit guide vanes - Vane retaining bolt replacement

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-306			Applicable Engine - LP turbine - Modified LP turbine bearing oil scavenge tube
OL 72-306 01			Applicable Engine - LP turbine - Modified LP turbine bearing oil scavenge tube
OL 72-306 02			Applicable Engine - LP turbine - Modified LP turbine bearing oil scavenge tube
OL 72-307			Not Applicable Engine - Internal accessory drives - Zerol bevel gearshaft damping plate (LH gearbox)
OL 72-307 01			Not Applicable Engine - Internal accessory drives - Zerol bevel gearshaft damping plate (LH gearbox)
OL 72-308			Not Applicable Engine - LH accessory gearbox - Main drive spiral bevel pinion with undercut fillet radius and shot peening
OL 72-308 01			Not Applicable Engine - LH accessory gearbox - Main drive spiral bevel pinion with undercut fillet radius and shot peening
OL 72-309			Not Applicable Engine - HP compressor rotor - Inspection of the No.12 labyrinth attachment bolts
OL 72-310			Not Applicable Engine - Combustion Chamber - Improved weld positioning on No. 2 inner and outer cooling ring scoops
OL 72-310 01			Not Applicable Engine - Combustion Chamber - Improved weld positioning on No. 2 inner and outer cooling ring scoops
OL 72-310 02			Not Applicable Engine - Combustion Chamber - Improved weld positioning on No. 2 inner and outer cooling ring scoops
OL 72-311			Not Applicable Engine - HP turbine bearing support - Introduction of increased oil flow and insulating blankets for the oil feed and scavenge end tubes

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
R	OL 72-311	01		Not Applicable Engine - HP turbine bearing support - Introduction of increased oil flow and insulating blankets for the oil feed and scavenge end tubes
R	OL 72-311	02		Not Applicable Engine - HP turbine bearing support - Introduction of increased oil flow and insulating blankets for the oil feed and scavenge end tubes
R	OL 72-311	03		Not Applicable Engine - HP turbine bearing support - Introduction of increased oil flow and insulating blankets for the oil feed and scavenge end tubes
R	OL 72-312			Not Applicable Engine - Combustion Chamber - Introduction of combustion chambers incorporating new vaporisers
R	OL 72-312	01		Not Applicable Engine - Combustion Chamber - Introduction of combustion chambers incorporating new vaporisers
R	OL 72-312	02		Not Applicable Engine - Combustion Chamber - Introduction of combustion chambers incorporating new vaporisers
	OL 72-313	01		Embodied Engine - HP compressor case and vanes - Anti-fret lines on stages 6 and 7 stator vanes
R	OL 72-313	02		Embodied Engine - HP compressor case and vanes - Anti-fret lines on stages 6 and 7 stator vanes
R	OL 72-314			Not Applicable Engine - HP turbine nozzle - Nozzle vane cone assembly retaining bolt replacement
R	OL 72-315			Not Applicable Engine - Combustion Chamber - Introduction of a modified combustion chamber with Sermaloy J coating applied

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-316	02		Applicable Engine - Combustion chamber - Reduction in quantity of locking rivets for vaporiser nuts from two to one
R	OL 72-317			Not Applicable Engine - LP and HP turbine assemblies - Additional scheduled maintenance task
	OL 72-318	01		Applicable Engine - Combustion chamber - Introduction of improved No.2 and No.3 inner and outer cooling rings (2 rings)
R	OL 72-318			CANCELLED
R	OL 72-320			Not Applicable Engine - HP compressor rotor - Eddy current and fluorescent dye penetrant inspection of HP compressor rotor disks stages 4-7
R	OL 72-321			Not Applicable Engine - Combustion chamber - Extension of Sermaloy J coating on front fairing and No.2 cooling rings
R	OL 72-321	01		Not Applicable Engine - Combustion chamber - Extension of Sermaloy J coating on front fairing and No.2 cooling rings
R	OL 72-321	02		Not Applicable Engine - Combustion chamber - Extension of Sermaloy J coating on front fairing and No.2 cooling rings
R	OL 72-322			Not Applicable Engine - Intermediate case seal ring assembly - Mod to ensure clearance with LP pulse probe bevel gear
R	OL 72-322	01		Not Applicable Engine - Intermediate case seal ring assembly - Mod to ensure clearance with LP pulse probe bevel gear
R	OL 72-323			Not Applicable Engine - HP compressor - reduction in cycle life of certain HP compressor rotor disks stage 1 (group A part)

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
R OL 72-323	01		Not Applicable Engine - HP compressor - reduction in cycle life of certain HP compressor rotor disks stage 1 (group A part)
R OL 72-324			Not Applicable Engine - HP compressor case and vanes - Inspection of oil cooler lower rear support bracket (B.489654)/bolthead and adjacent manifold tube
R OL 72-325			Not Applicable Engine - HP compressor rotor - cancellation of the modification which introduced a supply of heated air to bore of the stage 7 disk
R OL 72-326			Not Applicable Engine - HP compressor rotor - HP drive shaft additional maintenance task
R OL 72-326	01		Not Applicable Engine - HP compressor rotor - HP drive shaft additional maintenance task
R OL 72-327			Not Applicable Engine - Combustion chamber - Intro-duction of a modified combustion chamber assembly (To the standard of Service Bulletin OL.593-72-8679-282) having thickened vaporiser bosses
R OL 72-328	01		CANCELLED
R OL 72-329			Not Applicable Engine - Combustion chamber - Magnesium Zirconate coating on inner turbine entry duct
R OL 72-330			Not Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of boss welds on one piece CCOC
R OL 72-330	01		Not Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of boss welds on one piece CCOC
R OL 72-330	02		Not Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of boss welds on one piece CCOC

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-330	03		Not Applicable Engine - Combustion chamber outer case (CCOC) - Inspection of boss welds on one piece CCOC
OL 72-331			Not Applicable Engine - HP compressor rotor - Inspection of HP compressor drive shaft for cracks
OL 72-331	01		Not Applicable Engine - HP compressor rotor - Inspection of HP compressor drive shaft for cracks
R OL 72-331	02		Not Applicable Engine - HP compressor rotor - Inspection of HP compressor drive shaft for cracks
OL 72-332			Not Applicable Engine - HP turbine assembly No.23 labyrinth seal ring/damper ring securing bolts
OL 72-333			Not Applicable Engine - Combustion chamber outer case (CCOC) -Introduction of additional inspection frequencies
OL 72-334			Not Applicable Engine - Various - Introduction of EGT trend monitoring
OL 72-334	01		Not Applicable Engine - Various - Introduction of EGT trend monitoring
OL 72-334	02		Not Applicable Engine - Various - Introduction of EGT trend monitoring
OL 72-334	03		Not Applicable Engine - Various - Introduction of EGT trend monitoring
OL 72-334	04		Not Applicable Engine - Various - Introduction of EGT trend monitoring
R OL 72-334	05		Not Applicable Engine - Various - Introduction of EGT trend monitoring
OL 72-335			Not Applicable Engine - HP compressor rotor - Inspection of stage 1 HP compressor Rotor disk and blades for cracks

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-336			Not Applicable Engine - Accessory gearbox assembly, RH - Inspection of spiral bevel gear wheel assembly for cracks
OL 72-337			CANCELLED
OL 72-338	02		Applicable Engine - HP compressor rotor - Introduction of stage 1 disk and blades having anti-fret coating of PL239 (graphite) and shot peening of disk slots
OL 72-339			CANCELLED
OL 72-340			CANCELLED
OL 72-341	02		Applicable Engine - HP compressor rotor - Rebroach-ing of blade root slots of stage 6 disks to achieve life extension (Group A part)
OL 72-341	03		Applicable Engine - HP compressor rotor - Rebroach-ing of blade root slots of stage 6 disks to achieve life extension (Group A part)
OL 72-342			Applicable Engine - HP compressor case and vanes - Stage 7 anti-fret liners to suit single inspection port cases
OL 72-343			Not Applicable Engine - LH accessory gearbox - Chamfer on gearbox diaphragm load spreading washers
OL 72-344		Sep 30/93	Embodied Engine - HP compressor rotor - Rebroaching of blade root slots of stage 5 disks to achieve life extension (Group A part)
OL 72-344	01		Embodied Engine - HP compressor rotor - Rebroaching of blade root slots of stage 5 disks to achieve life extension (Group A part)

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SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-344	02		Embodied Engine - HP compressor rotor - Rebroaching of blade root slots of stage 5 disks to achieve life extension (Group A part)
OL 72-344	03		Embodied Engine - HP compressor rotor - Rebroaching of blade root slots of stage 5 disks to achieve life extension (Group A part)
OL 72-345			CANCELLED
OL 72-346	01	Sep 30/90	Embodied Engine - Air intake fairing - Eddy current inspection of support webs
OL 72-347	03		Applicable Engine - HP and LP compressors - Introduction of components with sermetel W and sermaseal corrosion protection
OL 72-348	03		Applicable Engine - LP compressor rotor - Inspection of second stage LP rotor blade fir-tree roots (rear face)
R OL 72-348	04		Applicable Engine - LP compressor rotor - Inspection of second stage LP rotor blade fir-tree roots (rear face)
OL 72-349			CANCELLED
OL 72-350	01		Applicable Engine - Nozzle turbine LP - Improved swaging and tack welding of thermocouple guide tubes
OL 72-351			Not Applicable Engine - LP compressor rotor - Inspection of second stage LP rotor blade fir tree roots (front face)
OL 72-351	01		Not Applicable Engine - LP compressor rotor - Inspection of second stage LP rotor blade fir tree roots (front face)

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
R	OL 72-351	02		Not Applicable Engine - LP compressor rotor - Inspection of second stage LP rotor blade fir tree roots (front face)
	OL 72-352	02		Applicable Engine - Detailed inspection and cyclic test requirement programme (Group A parts)
	OL 72-352	03		Applicable Engine - Detailed inspection and cyclic test requirement programme (Group A parts)
	OL 72-352	04		Applicable Engine - Detailed inspection and cyclic test requirement programme (Group A parts)
	OL 72-353	01		Applicable Engine - HP compressor rotor - Inspection of No.12 labyrinth for cracks
	OL 72-354	01		Applicable Engine - Right and left-hand accessory gearboxes - Inspection of self-locking shaft nuts
	OL 72-355			Applicable Engine - HP and LP turbine hub assemblies - Inspection for cracking in hirth serrations
	OL 72-355	01		Applicable Engine - HP and LP turbine hub assemblies - Inspection for cracking in hirth serrations
	OL 72-356	01		Applicable Engine - LP compressor rotor - Second stage LP blades with root extension undercut and shot peening
R	OL 72-356	02		Applicable Engine - LP compressor rotor - Second stage LP blades with root extension undercut and shot peening

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-357	02	Sep 30/93	Embodied Engine - HP compressor rotor - Inspection of stages 2 and 3 rotor disks and stage 2 to 3 spacer for corrosion damage
OL 72-357			CANCELLED
OL 72-358	01		Applicable Engine - HP compressor rotor - Stages 2 and 3 rotor disks with sermetel 709 in blade root slots
OL 72-358			CANCELLED
OL 72-359	01		Applicable Engine - HP turbine - Inspection of HP turbine rotor blades for cracking
OL 72-360			Applicable Engine - HP compressor rotor - Inspection of stages 1 to 3 blades for damage
OL 72-361			Applicable Engine - HP and LP turbine rotor disks - Shot peening to improve fatigue resist-ance
OL 72-361	01		Applicable Engine - HP and LP turbine rotor disks - Shot peening to improve fatigue resist-ance
OL 72-362			Applicable Engine - HP compressor rotor - Life limitation for HP compressor stage 3 rotor disk
OL 72-362			CANCELLED
OL 72-363		Sep 30/93	Embodied Engine - HP compressor rotor - Intro-duction of HP compressor drive shaft with guard holes
OL 72-364			Not applicable Engine - Group A parts inspection requirements
R OL 72-364	01		Not applicable Engine - Group A parts inspection requirements

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-364	02		Not applicable Engine - Group A parts inspection requirements
OL 72-364	03		Not applicable Engine - Group A parts inspection requirements
OL 72-364	04		Not applicable Engine - Group A parts inspection requirements
OL 72-364	05		Not applicable Engine - Group A parts inspection requirements
OL 72-364	06		Not applicable Engine - Group A parts inspection requirements
R OL 72-364	07		Not applicable Engine - Group A parts inspection requirements
OL 72-365			Applicable Engine - LH accessory gearbox - Intro-duction of stiffened radial drive shaft
OL 72-366	02		Applicable Engine - HP turbine assembly - HP turbine hub with machined hirth serrations
OL 72-366	03		Applicable Engine - HP turbine assembly - HP turbine hub with machined hirth serrations
OL 72-367	01		Not applicable Engine - LP compressor rotor disks (stages 2-7) improvements in IMI 550 titanium quality standard
OL 72-367	02		Not applicable Engine - LP compressor rotor disks (stages 2-7) improvements in IMI 550 titanium quality standard
OL 72-367	03		Not applicable Engine - LP compressor rotor disks (stages 2-7) improvements in IMI 550 titanium quality standard
OL 72-367	04		Not applicable Engine - LP compressor rotor disks (stages 2-7) improvements in IMI 550 titanium quality standard

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
R	OL 72-367	05		Not applicable Engine - LP compressor rotor disks (stages 2-7) improvements in IMI 550 titanium quality standard
	OL 72-368	02	Sep 30/93	Not applicable Engine - LP compressor (stage 1) disk, LP compressor spacers, HP compressor (stage 1) disk and HP compressor rotor shaft front - Improvements in IMI 550 titanium quality standard
	OL 72-368	03		Not applicable Engine - LP compressor (stage 1) disk, LP compressor spacers, HP compressor (stage 1) disk and HP compressor rotor shaft front - Improvements in IMI 550 titanium quality standard
	OL 72-368	04		Not applicable Engine - LP compressor (stage 1) disk, LP compressor spacers, HP compressor (stage 1) disk and HP compressor rotor shaft front - Improvements in IMI 550 titanium quality standard
	OL 72-368	05		Not applicable Engine - LP compressor (stage 1) disk, LP compressor spacers, HP compressor (stage 1) disk and HP compressor rotor shaft front - Improvements in IMI 550 titanium quality standard
	OL 72-368	06		Not applicable Engine - LP compressor (stage 1) disk, LP compressor spacers, HP compressor (stage 1) disk and HP compressor rotor shaft front - Improvements in IMI 550 titanium quality standard
R	OL 72-368	07		Not applicable Engine - LP compressor (stage 1) disk, LP compressor spacers, HP compressor (stage 1) disk and HP compressor rotor shaft front - Improvements in IMI 550 titanium quality standard

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SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-369		Sep 30/93	Embodied Engine - HP compressor rotor - Introduction of stage 1 HP compressor rotor disk manufactured in triple melt titanium alloy
OL 72-370			Applicable Engine - Outer air duct - Inspection of wall section thickness
OL 72-371			Applicable Engine - Combustion chamber - Introduction of a combustion chamber with a modified front fairing
OL 72-371	01		Applicable Engine - Combustion chamber - Introduction of a combustion chamber with a modified front fairing
OL 72-372			Applicable Engine - LP turbine nozzle - Introduction of a thermocouple vane assembly produced from existing stocks of standard LP nozzle guide vanes (NGV)
OL 72-372	01		Applicable Engine - LP turbine nozzle - Introduction of a thermocouple vane assembly produced from existing stocks of standard LP nozzle guide vanes (NGV)
OL 72-373			Applicable Engine - HP compressor rotor - Introduction of HP rotor shaft front manufactured in triple melt titanium alloy
OL 72-374			Applicable Engine - Accessory gearbox assembly LH - Introduction of improved parallel roller journal bearings
OL 72-374	01		Applicable Engine - Accessory gearbox assembly LH - Introduction of improved parallel roller journal bearings

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-375			Applicable Engine - LP compressor rotor - Inspection of blades (stages 1-4) for excessive twist
R OL 72-376			CANCELLED
OL 72-377			Applicable Engine - Combustion chamber - Introduction of an alternative thermal barrier coating with extended application
OL 72-377	01		Applicable Engine - Combustion chamber - Introduction of an alternative thermal barrier coating with extended application
OL 72-377	02		Applicable Engine - Combustion chamber - Introduction of an alternative thermal barrier coating with extended application
OL 72-378		Sep 30/93	Embodied Engine - HP turbine rotor - Periodic inspection of the HP turbine hub
OL 72-379			Applicable Engine - Air intake fairing - Introduction of stiffened fairing in titanium
OL 72-379	01		Applicable Engine - Air intake fairing - Introduction of stiffened fairing in titanium
OL 72-380			Applicable Engine - Combustion chamber - Reinstatement of eight groups of four inner blown holes
OL 72-380	01		Applicable Engine - Combustion chamber - Reinstatement of eight groups of four inner blown holes
OL 72-381			Applicable Engine - Air transfer tube - Increased bore diameter
OL 72-381	01		Applicable Engine - Air transfer tube - Increased bore diameter

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-381	02		Applicable Engine - Air transfer tube - Increased bore diameter
	OL 72-382			Applicable Engine - Air intake - Installation of packing plate(s) between air intake casing and anti-icing manifold
	OL 72-383	02		Applicable Engine - LH accessory gearbox - Introduction of new bevel gears and integral bearing for left hand gearbox input drives
	OL 72-383	03		Applicable Engine - LH accessory gearbox - Introduction of new bevel gears and integral bearing for left hand gearbox input drives
	OL 72-383	04		Applicable Engine - LH accessory gearbox - Introduction of new bevel gears and integral bearing for left hand gearbox input drives
	OL 72-384			Applicable Engine - HPC stage 3 rotor blades - Blade root ultrasonic inspection
R	OL 72-384	01		Applicable Engine - HPC stage 3 rotor blades - Blade root ultrasonic inspection
R	OL 72-384	02		Applicable Engine - HPC stage 3 rotor blades - Blade root ultrasonic inspection
R	OL 72-384	03		Applicable Engine - HPC stage 3 rotor blades - Blade root ultrasonic inspection
R	OL 72-384	04		Applicable Engine - HPC stage 3 rotor blades - Blade root ultrasonic inspection
R	OL 72-384	05		Applicable Engine - HPC stage 3 rotor blades - Blade root ultrasonic inspection

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-385			Applicable Engine - HP compressor rear casing - Rear flange bolt holes coated with sermetal 709 type C
OL 72-386			Applicable Engine - Air intake case - Introduction of half seal in feroform (F61) material
OL 72-387			Applicable Engine - Combustion chamber - Inspection frequencies
OL 72-388			Applicable Engine - Combustion chamber - Inspection for suitability of front fairing to No.2 outer cooling ring weld
OL 72-389			Applicable Engine - LP turbine - Nozzle guide vane vent hole plugging
OL 72-389	01		Applicable Engine - LP turbine - Nozzle guide vane vent hole plugging
OL 72-389	02		Applicable Engine - LP turbine - Nozzle guide vane vent hole plugging
OL 72-390			Not Applicable Engine - HPC Stage 2 rotor blades - Blade root intrascope inspection for cracks
OL 72-390	01		Not Applicable Engine - HPC Stage 2 rotor blades - Blade root intrascope inspection for cracks
R OL 72-390	02		Not Applicable Engine - HPC Stage 2 rotor blades - Blade root intrascope inspection for cracks
OL 72-391			CANCELLED
OL 72-392			Not Applicable Engine - HPC Stage 2 and 3 rotor blades - Blade root inspection
OL 72-393			Not Applicable Engine - Oil pressure pump case extended pressure relief slot
OL 72-393	01		Not Applicable Engine - Oil pressure pump case extended pressure relief slot

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-394			Not Applicable Engine - Combustion Chamber - Radiological inspection of front fairing to No.2 inner and outer cooling ring welds
OL 72-395			CANCELLED
OL 72-396			Not Applicable Engine - HP compressor rotor - Introduction of stages 2 and 3 HP compressor blades with non-preferential pitch on the blade root serrations
OL 72-396	01		Not Applicable Engine - HP compressor rotor - Introduction of stages 2 and 3 HP compressor blades with non-preferential pitch on the blade root serrations
OL 72-396	02		Not Applicable Engine - HP compressor rotor - Introduction of stages 2 and 3 HP compressor blades with non-preferential pitch on the blade root serrations
OL 72-396	03		Not Applicable Engine - HP compressor rotor - Introduction of stages 2 and 3 HP compressor blades with non-preferential pitch on the blade root serrations
R OL 72-396	04		Not Applicable Engine - HP compressor rotor - Introduction of stages 2 and 3 HP compressor blades with non-preferential pitch on the blade root serrations
OL 72-398			Not Applicable Engine - HP compressor - Deletion of special lifting rules
OL 72-398	01		Not Applicable Engine - HP compressor - Deletion of special lifting rules
OL 72-399			Not Applicable Engine - LH accessory gearbox - Introduction of "faced" nuts for retention of roller bearings

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-399	01		Not Applicable Engine - LH accessory gearbox - Introduction of "faced" nuts for retention of roller bearings
	OL 72-400			Not Applicable Engine - LP compressor - Replacement of externally relieved LPC Stage 7 disc to LPC Stage 6/7 spacer retaining bolts
R	OL 72-400	01		Not Applicable Engine - LP compressor - Replacement of externally relieved LPC Stage 7 disc to LPC Stage 6/7 spacer retaining bolts
	OL 72-401			Applicable Engine - Oil Seals - Replacement of QAD corruplus seals at first stage pump, fuel control unit and integrated drive generator with 'O' ring type seals, to overcome oil leaks
	OL 72-402			Not Applicable Engine - HP compressor rotor - Stage 2 and 3 discs with corrosion protection removed from loaded flanks
R	OL 72-402	01		Not Applicable Engine - HP compressor rotor - Stage 2 and 3 discs with corrosion protection removed from loaded flanks
	OL 72-403			Not Applicable Engine - LH gearbox - Introduction of idler shaft with improved bearing abutment
	OL 72-403	01		Not Applicable Engine - LH gearbox - Introduction of idler shaft with improved bearing abutment
	OL 72-403	02		Not Applicable Engine - LH gearbox - Introduction of idler shaft with improved bearing abutment

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-404			Not Applicable Engine - Intermediate case - Replacement of Metaflex seals with Kalrez 'O' ring type seals
OL 72-404	01		Not Applicable Engine - Intermediate case - Replacement of Metaflex seals with Kalrez 'O' ring type seals
OL 72-404	02		Not Applicable Engine - Intermediate case - Replacement of Metaflex seals with Kalrez 'O' ring type seals
OL 72-405			Not Applicable Engine - LP compressor rotor shaft front - Discs and spacers material change
OL 72-405	01		Not Applicable Engine - LP compressor rotor shaft front - Discs and spacers material change
OL 72-406			Not Applicable Engine - Right-hand gearbox - Replacement of Metaflex seals on the oil filters (pressure and scavenge) by Viton seals
OL 72-407			Applicable Engine - Asbestos gaskets replaced with non-asbestos
OL 72-407	01		Applicable Engine - Asbestos gaskets replaced with non-asbestos
OL 72-407	02		Applicable Engine - Asbestos gaskets replaced with non-asbestos

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-407	03		Applicable Engine - Asbestos gaskets replaced with non-asbestos
OL 72-408			Not Applicable Engine - Intermediate case - Air blown seals "Ferobestos" packing rings replaced with "Supergraf" seals
OL 72-408	01		Not Applicable Engine - Intermediate case - Air blown seals "Ferobestos" packing rings replaced with "Supergraf" seals
OL 72-408	02		Not Applicable Engine - Intermediate case - Air blown seals "Ferobestos" packing rings replaced with "Supergraf" seals
OL 72-408	03		Not Applicable Engine - Intermediate case - Air blown seals "Feebestos" packing rings replaced with "Supergraf" seals
OL 72-409			Applicable Engine - Air intake fairing - Introduction of damper spring with improved retention feature and addition of glass cloth tape at spring location replaced with "Supergraf" seals
OL 72-409	01		Applicable Engine - Air intake fairing - Introduction of damper spring with improved retention feature and addition of glass cloth tape at spring location
OL 72-410			Not Applicable Engine - Combustion chamber outer casing (CCOC) - Introduction of LP NGV front location groove with anti-fret liner
OL 72-410	01		Not Applicable Engine - Combustion chamber outer casing (CCOC) - Introduction of LP NGV front location groove with anti-fret liner

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-410	02		Not Applicable Engine - Combustion chamber outer casing (CCOC) - Introduction of LP NGV front location groove with anti-fret liner
	OL 72-411			Not Applicable Engine - HP compressor rotor - Driveshaft to air transfer tube, reduced spigot diameter (Rework standard only)
	OL 72-412			Not Applicable Engine - Combustion chamber - Improved processes and control of sub-assemblies
	OL 72-412	01		Not Applicable Engine - Combustion chamber - Improved processes and control of sub-assemblies
R	OL 72-412	02		Not Applicable Engine - Combustion chamber - Improved processes and control of sub-assemblies
	OL 72-413			Not Applicable Engine - LH accessory gearbox - Introduction of improved roller bearings for the idler gearshaft rear and first stage fuel pump drive shaft
	OL 72-414			Not Applicable Engine - Combustion chamber outer casing (CCOC) - Plugging and re-positioning of LP NGV cooling holes
	OL 72-414	01		Not Applicable Engine - Combustion chamber outer casing (CCOC) - Plugging and re-positioning of LP NGV cooling holes
	OL 72-414	02		Not Applicable Engine - Combustion chamber outer casing (CCOC) - Plugging and re-positioning of LP NGV cooling holes positioning of LP NGV cooling holes

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-414	03		Not Applicable Engine - Combustion chamber outer casing (CCOC) - Plugging and re-positioning of LP NGV cooling holes
OL 72-416			Not Applicable Engine - HP compressor rotor - Lifting and inspection requirements for rebroached stage 6 discs
OL 72-416	01		Not Applicable Engine - HP compressor rotor - Lifting and inspection requirements for rebroached stage 6 discs
OL 72-417			Not Applicable Engine - combustion chamber - Radiological inspection of the number 2 outer cooling ring scoop circumferential and both axial welds
OL 72-418			Not Applicable Engine - Combustion chamber outer case - Inspection to ensure that part number reflects the actual item configuration standard
OL 72-419		Mar 27/97	Applicable Engine - Oil pump body, right-hand gearbox and master magnetic chip detector (MCD) - Secondary sealing introduced to MCD's and filter cover drain plugs deleted
OL 72-419	01		Applicable Engine - Oil pump body, right-hand gearbox and master magnetic chip detector (MCD) - Secondary sealing introduced to MCD's and filter cover drain plugs deleted
OL 72-419	02		Applicable Engine - Oil pump body, right-hand gearbox and master magnetic chip detector (MCD) - Secondary sealing introduced to MCD's and filter cover drain plugs deleted

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-419	03		Applicable Engine - Oil pump body, right-hand gearbox and master magnetic chip detector (MCD) - Secondary sealing introduced to MCD's and filter cover drain plugs deleted
OL 72-420			Not Applicable Engine - LP compressor rotor centre rear - Asbestos Metaflex seal replaced by a non-asbestos version
OL 72-421			Not Applicable Engine - Combustion chamber - Inspection for suitability of front fairing to No. 2 outer cooling ring weld
OL 72-422			Not Applicable Engine - Exhaust diffuser - Vane crack detection using X-Ray inspection technique
OL 72-422	01		Not Applicable Engine - Exhaust diffuser - Vane crack detection using X-Ray inspection technique
OL 72-423			Not Applicable Engine - Exhaust diffuser - Vane crack detection using ulstrasonic inspection technique
OL 72-423	01		Not Applicable Engine - Exhaust diffuser - Vane crack detection using ulstrasonic inspection technique
OL 72-423	02		Not Applicable Engine - Exhaust diffuser - Vane crack detection using ulstrasonic inspection technique
OL 72-423	03		Not Applicable Engine - Exhaust diffuser - Vane crack detection using ulstrasonic inspection technique

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-424			Not Applicable Engine - Combustion chamber - Inspection to ensure acceptability of the No. 2 inner and outer cooling ring web length
OL 72-425			Not Applicable Engine - LP Compressor Driveshaft Rear - Inspection to ensure the integrity of components previously repaired by blending
OL 72-426			Not Applicable Engine - Intermediate Case - Replacement of Kalrez and Metaflex seals with metal 'C' seals to improve sealing
OL 72-426	01		Not Applicable Engine - Intermediate Case - Replacement of Kalrez and Metaflex seals with metal 'C' seals to improve sealing
R OL 72-426	02		Not Applicable Engine - Intermediate Case - Replacement of Kalrez and Metaflex seals with metal 'C' seals to improve sealing
OL 72-427			Not Applicable Engine - Outer Air Duct - Inspection for cracks
OL 72-427	01		Not Applicable Engine - Outer Air Duct - Inspection for cracks
OL 72-428			Not Applicable Engine - HP Compressor Rotor - Lifting and inspection requirements for rebroached stage 5 discs
R OL 72-428	01		Not Applicable Engine - HP Compressor Rotor - Lifting and inspection requirements for rebroached stage 5 discs
R OL 72-428	02		Not Applicable Engine - HP Compressor Rotor - Lifting and inspection requirements for rebroached stage 5 discs

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-429			Not applicable Engine - HP Turbine Rotor - Introduction of HP turbine blade with revised air dam profile
	OL 72-430			Not Applicable Engine - HP Turbine Rotor - Introduction of HP turbine blade with improved corrosion protection (Platinum Aluminising)
	OL 72-431			Not Applicable Engine - Labyrinth Ring Seal Nos.24 and 26 - Inspection for cracks and dimensional check of spigots
R	OL 72-431	01		Not Applicable Engine - Labyrinth Ring Seal Nos.24 and 26 - Inspection for cracks and dimensional check of spigots
	OL 72-432			Not Applicable Engine - LP Turbine Rotor Disc - Inspect for blending in bolt holes
	OL 72-434			Not Applicable Engine - LP Compressor - Introduction of stator ring liner (front) with revised tang extension
	OL 72-435			Not Applicable Engine - Combustion Chamber - Thickened thermal barrier coating on No.2 and No.3 inner and outer cooling rings
R	OL 72-435	01		Not Applicable Engine - Combustion Chamber - Thickened thermal barrier coating on No.2 and No.3 inner and outer cooling rings

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
OL 72-436			Applicable Engine - Introduction of Material change to hot end bolts from Nimonic 80A to Waspaloy, with lubrication change from graphite grease to engine oil or anti-seize compound, with associated torque tightening change
OL 72-437			Not Applicable Engine - Left-Hand Accessory Gearbox - Inspection of the governor/first stage fuel pump quill shaft screwed plug peening
OL 72-438			Not applicable Engine - Combustion Chamber - Introduction of a revised method of manufacture (3 piece head)
OL 72-438	01		Not applicable Engine - Combustion Chamber - Introduction of a revised method of manufacture (3 piece head)
OL 72-438	02		Not applicable Engine - Combustion Chamber - Introduction of a revised method of manufacture (3 piece head)
R OL 72-438	03		Not applicable Engine - Combustion Chamber - Introduction of a revised method of manufacture (3 piece head)
OL 72-439			Not applicable Engine - No.4 HP Turbine Bearing - Introduction of bearing with individual part numbers for inner and outer tracks
OL 72-440			Not applicable Engine - HP Nozzle Guide Vanes - Introduction of an electron beam physical vapour deposition thermal barrier coating to the leading and trailing edges
OL 72-441			Not applicable LH Engine - Oil Pressure Filter blockage due to the shedding of carbon and/or anti-wear addative

	SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
	OL 72-441	01		Not applicable LH Engine - Oil Pressure Filter blockage due to the shedding of carbon and/or anti-wear addative
R	OL 72-441	02		Not applicable LH Engine - Oil Pressure Filter blockage due to the shedding of carbon and/or anti-wear addative
	OL 72-442			Not applicable Engine - HP Compressor - One off inspection of HP2 Blade aerofoils for damage
R	OL 72-442	01		Not applicable Engine - HP Compressor - One off inspection of HP2 Blade aerofoils for damage
	OL 72-443			Not applicable Engine - HP Compressor Front Case - Dovetail slots with anti-fret liners at stages 1, 2, 3 and 5
R	OL 72-443	01		Not applicable Engine - HP Compressor Front Case - Dovetail slots with anti-fret liners at stages 1, 2, 3 and 5
	OL 72-444			Not applicable Engine - Vaporiser Identification Inspection
R	OL 72-444	01		Not applicable Engine - Vaporiser Identification Inspection
	OL 72-445			Not applicable Engine - LPT Hub - One off inspection for open twins
R	OL 72-446			Not applicable Engine - HP Compressor Drive Shaft - One off inspection for open twins
R	OL 72-447			Not applicable Engine - Inspection and functional checks prior to return to service

SB/AEB NO	REV	INC. IN REVISION	DESCRIPTION
R OL 72-448			Not applicable Engine - Non asbestos gaskets replaced with "O" seals to improve sealing performance at the ATS, FCU, IDG and FSP QAD locations
OL 77-010		May 30/77	Embodied Engine indicating - Engine power pitots - New pitot tube
OL 77-011		May 30/77	Embodied Engine indicating - Engine power pitots - Additional support brackets
OL 79-006		May 30/77	Embodied Oil - Oil tank/overflow drain coupling - Modified main oil tank

CHAPTER 72

ENGINE

TABLE OF CONTENTS

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GENERAL - DESCRIPTION AND OPERATION

1. Description

The Olympus 593 engine is a straight flow, twin spool turbo-jet, employing compound mechanically independent axial flow compressors driven by separate axial flow turbines. The two rotating assemblies are supported co-axially in five main bearings at the positions shown in the illustration (Ref. Fig. 001)

The compressor section consists of a seven stage low pressure (LP) compressor, an intermediate case, a seven stage high pressure (HP) compressor and a compressor diffuser case. The compressors are arranged in tandem and connect to their associated HP and LP turbine rotors by co-axial shafts.

The combustion section, situated at the rear of the compressor section, consists of an annular combustion chamber enclosed by an outer combustion chamber case.

The turbine section consists of HP and LP turbine rotor assemblies and a turbine exhaust diffuser assembly. The HP and LP turbine rotors are arranged in tandem and situated to the rear of the combustion section. The exhaust diffuser, which incorporates a reheat injection system, is mounted behind the LP turbine rotor.

The accessory drives, which include the internal accessory drives from the HP and LP shafts, are housed within the intermediate case and left-hand and right-hand gearboxes. The internal drives transmit the shaft drive to the left-hand and right-hand gearboxes and the LP pulse probe drive and housing. Engine driven accessories are mounted on the front and rear faces of the gearboxes while the main oil pump of the engine lubrication system is situated in the base of the left-hand gearbox.

Pressurization, cooling and anti-icing air systems are provided on the engine.

2. Operation

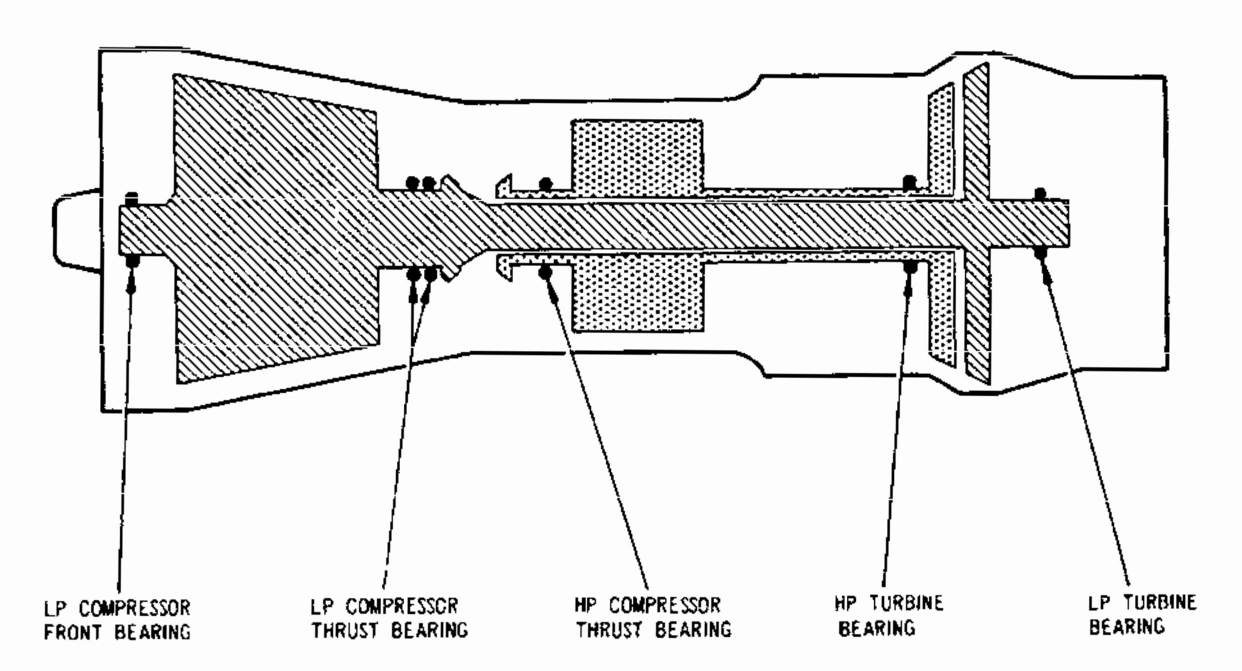
Air is delivered by the aircraft air intake to the engine, it passes via the LP and HP compressors, where its pressure is increased, into the combustion chamber. Here fuel is mixed with the air and the mixture burned.

Some of the increased energy in the gas flow generated by the combustion of the fuel, drives the turbine assemblies

CR 30377/00A

 LP ROTATING ASSEMBLY

 HP ROTATING ASSEMBLY



CMR 72 00 00 0 AAM0

Rotating Assemblies
Figure 001

and sufficient power is extracted by them to drive the compressors. The gas flow containing the residual energy, leaves the engine via the exhaust diffuser and primary nozzle that direct it into the aircraft secondary nozzle structure and thence to atmosphere.

ENGINE LUBRICATION SYSTEM - DESCRIPTION AND OPERATION

1. General

The lubrication system on each engine is completely self contained as shown in the illustration (Ref. Fig. 001). Oil is circulated around the five bearings of the HP and LP rotating assemblies and the gears and bearings of the two gearboxes by a series of pressure and scavenge pumps. An oil pump (Ref. 72-65-00) mounted on the left-hand gearbox, houses the pressure pump and four of the five scavenge pumps contained in the system. The fifth scavenge pump is incorporated in the right-hand gearbox (Ref. 72-63-00).

External tubes are used to link each bearing compartment and the right-hand gearbox to the main oil pump.

A storage tank for the oil supply, a fuel cooled oil cooler and associated supply and return tubes are described in 79-00-00. Warnings and indications in respect of oil temperature and pressure are displayed in the aircraft flight compartment.

R 2. Pressure and Scavenge Pumps (Ref. Fig. 002)

The spur gear type pressure and scavenge pumps, installed in the main oil pump case, are assembled in a vertical sequence. The pressure pump gears are located at the base of the assembly with four pairs of scavenge pump gears mounted above them. The drive to the pumps is from a quill shaft in the left-hand gearbox as described in 72-62-00. The fifth scavenge pump is located in the right-hand gearbox.

3. Tubes (Ref. Fig. 003)

Rigid metal oil pressure feed tubes and oil scavenge tubes have flanged ends and gaskets for attachment to the main oil pump and the gearbox connections. Union connections are used for attachment to feed and scavenge connections at the engine bearing compartments.

4. Oil Tube Filters (Ref. Fig. 004)

Cylindrical gauze filters are housed in the LP compressor front bearing feed and scavenge lines.

A pressure filter assembly is housed in an oil feed and vent flange assembly on the lower left-hand side of the air intake case and retained by the pressure feed tube union nut. An end cap on the inlet end of the filter has four slots that form oil passageways to the outside surface. The outlet from

CR 31177/00A

RIGHT HAND GEARBOX (72-63-00)

OIL TANK (79-00-00)

TO LP SHAFT SIGNAL SYSTEM GENERATING MECHANISM

LP COMPRESSOR FRONT BEARING

HP COMPRESSOR THRUST BEARING

HP TURBINE BEARING

LP COMPRESSOR THRUST BEARING

PULSE PROBE DRIVE AND HOUSING SUMP

LP TURBINE BEARING

MASTER MAGNETIC PLUG (79-00-00)

OIL COOLER (79-00-00)

MAIN OIL PUMP (72-65-00)

LEFT HAND GEARBOX (72-62-00)

CMR 72 01 00 0 AAMO

Engine Lubrication System Diagram
Figure 001

CR 31176 '00A

A

HP TURBINE BEARING SCAVENGE PUMP

HP AND LP COMPRESSOR THRUST BEARINGS AND LEFT-HAND GEARBOX SCAVENGE PUMP

TO LEFT-HAND GEARBOX AND HP AND LP TURBINE BEARINGS

LP TURBINE BEARING SCAVENGE PUMP

LEFT-HAND GEARBOX

TO OIL TANK

FROM LP COMPRESSOR FRONT BEARING

FROM OIL TANK

CMR 72 01 00 0 BAMA

TO LP COMPRESSOR FRONT BEARING AND HP AND LP COMPRESSOR THRUST BEARINGS AND RIGHT-HAND GEARBOX

A

PRESSURE PUMP

LP COMPRESSOR FRONT BEARING SCAVENGE PUMP

FROM HP AND LP COMPRESSOR THRUST BEARINGS

FROM LP TURBINE BEARING

FROM HP TURBINE BEARING

SUPPLY OIL FROM TANK

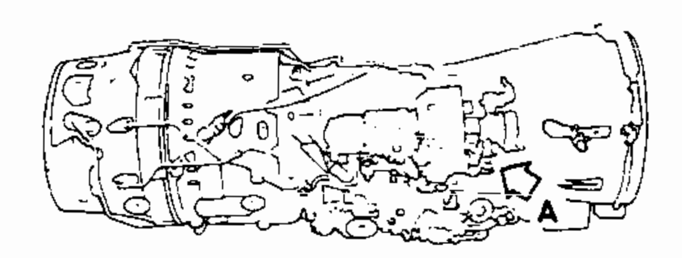
PRESSURE FEED OIL

SCAVENGE OIL FROM ENGINE BEARINGS

RETURN OIL TO TANK

Pressure and Scavenge Pumps (Sheet 1 of 2)
Figure 002

CR 31238 00A





FORWARD

AIR STARTER

SCAVENGE PUMP

INLET FROM GEARBOX SUMP

RIGHT-HAND GEARBOX

RETURN TO OIL TANK

A

CMR 72 01 00 0 BAMB

Pressure and Scavenge Pumps (Sheet 2 of 2)
Figure 002

CR 31180 00A

TO HP AND LP COMPRESSOR THRUST BEARINGS

TO PRESSURE TRANSMITTER AND LOW PRESSURE WARNING SWITCH

TO LP TURBINE BEARING

TO LP COMPRESSOR FRONT BEARING

TO RIGHT-HAND GEARBOX

TO HP TURBINE BEARING

OIL FEED TUBES-PUMP TO BEARINGS

CMR 72 01 00 0 CAMO

FROM HP TURBINE BEARING

FROM LP COMPRESSOR FRONT BEARING

FROM HP AND LP COMPRESSOR THRUST BEARINGS

FROM LP TURBINE BEARING

OIL SCAVENGE TUBES-BEARINGS TO PUMP

Oil Pressure Feed and Scavenge Tubes
Figure 003

the inside of the filter is restricted by a metering jet at the end.

A scavenge filter assembly is located in a housing in the scavenge tube and is retained with a union nut and blanking ferrule. At the inlet end of the filter an end cap provides an oil passageway into the inner surfaces of the filter.

5. Scavenge and Pressure Filters

Easy access is available to all main scavenge and pressure filters to facilitate servicing requirements. The direction of the oil flow through the single and double element filter units is described in paragraphs 9 and 10.

Details of filters installed in the main oil pump and right-hand gearbox are given in chapters 72-65-00 and 72-63-00 respectively.

6. Drain Valve and Magnetic Plug Assemblies (Ref. Fig.005 and 006)

A drain valve and magnetic plug assembly, located at the base of the right-hand gearbox scavenge filter, supplements the master magnetic plug described in 79-00-00. Provision is also made for magnetic plugs to be installed, if required, in the drain valves located at the base of each scavenge filter in the main oil pump.

R S.B.OL.593-72-419 introduces secondary sealing to the magnetic
R plugs and filter covers, and deletes the filter cover drain
R plugs to reduce the possibility of oil leakage (Ref. Fig.006).

The magnetic plug consists of a magnetic probe inserted in a threaded base. The plug is screwed into a drain valve body that houses a spring-loaded valve. When installed on the engine, the valve is held in the open position by the magnetic plug and the plug probe projects into the oil passage. As the plug is removed for servicing, the drain valve closes.

7. Indicators and Warning Switches

An oil pressure transmitter and a low oil pressure switch are installed on the pulse probe drive and housing rear face below the intermediate case. Two probes with sealed ends are installed in close proximity to the LP and HP compressor thrust bearings. A restrictor is located in the oil feed passage to the probes transmitter and switch.

The switch and transmitter are connected to the aircraft flight compartment warning and indication system as described in 79-00-00.

CR 31179 00A

PRESSURE FEED FILTER LOCATION

MAIN OIL PUMP

HP TURBINE BEARING SCAVENGE FILTER LOCATION

LP TURBINE BEARING SCAVENGE FILTER LOCATION

LP AND HP COMPRESSOR THRUST BEARINGS AND LEFT HAND GEARBOX SCAVENGE FILTER LOCATION

B

A

CMR 72 01 00 0 DAMO

RIGHT HAND GEARBOX

RIGHT HAND GEARBOX SCAVENGE FILTER LOCATION

RIGHT HAND GEARBOX PRESSURE FEED FILTER LOCATION

A

LP COMPRESSOR FRONT BEARING PRESSURE FEED

B

LP COMPRESSOR FRONT BEARING SCAVENGE FILTER

Locations of Filters
Figure 004

CR 3119 I 00A

MASTER MAGNETIC
PLUG LOCATION
(79-00-00)

A

DRAIN VALVE CLOSED
(MAGNETIC PLUG REMOVED)

MAGNETIC PLUG
LOCKING FACILITY

A

SCAVENGE FILTER
BASE

RIGHT-HAND GEARBOX

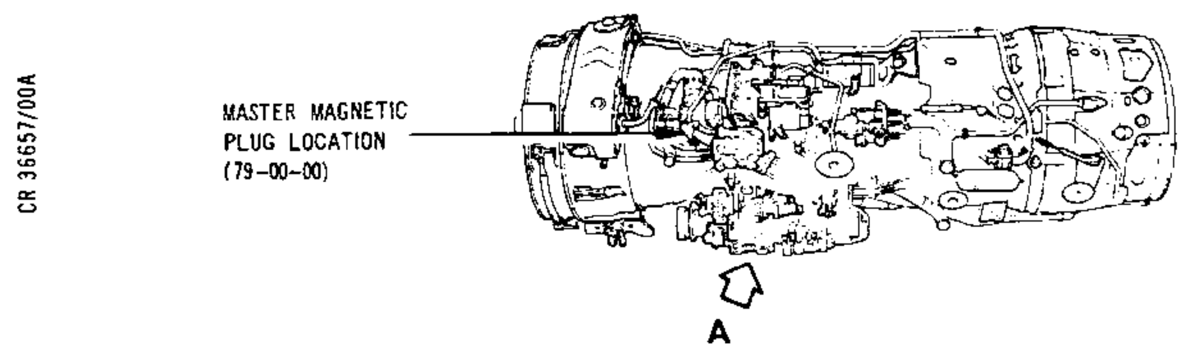
DRAIN VALVE
UNSEATED

MAGNETIC PLUG

CMR 72 01 00 0 EAM0

R

Magnetic Plug Locations
(Pre SB.OL.593-72-9036-419)
Figure 005



DRAIN VALVE CLOSED
(MAGNETIC PLUG REMOVED)

MAGNETIC PLUG
LOCKING FACILITY

SCAVENGE FILTER
BASE

RIGHT-HAND GEARBOX

A

DRAIN VALVE
UNSEATED

MAGNETIC PLUG

R Magnetic Plug Locations
R (SB.OL.593-72-9036-419)
R Figure 006

8. Gearbox Mounted Accessories

The driving splines of the gearbox mounted accessories are lubricated by engine oil as part of gearbox oil distribution. Details of the drives are given in Chapters 72-65-00 and 72-63-00.

R 9. Operation of the Engine Oil Pressure System (Ref. Fig.007)

Oil from the storage tank is supplied to the pressure pump inlet of the main oil pump. The engine driven pump delivery, at a pressure limited by a relief valve, passes through a pressurizing valve and filter and internal passages to the left-hand gearbox and a pressure feed outlet connection at the front of the pump. The direction of the oil flow
R through the filter is shown in illustration (Ref. Fig.009), to indicate the location of any contamination . Some of the oil entering the gearbox is delivered to a rearward facing pressure oil feed outlet connection on the side of the gearbox case.

The relief valve setting ensures an oil pressure delivery greater than the air pressure in the engine main bearing chambers. Oil flow relieved by the valve is returned direct to the pump inlet.

The left-hand gearbox drives and bearings are lubricated by oil sprayed from jets receiving feed pressure oil via internal passages.

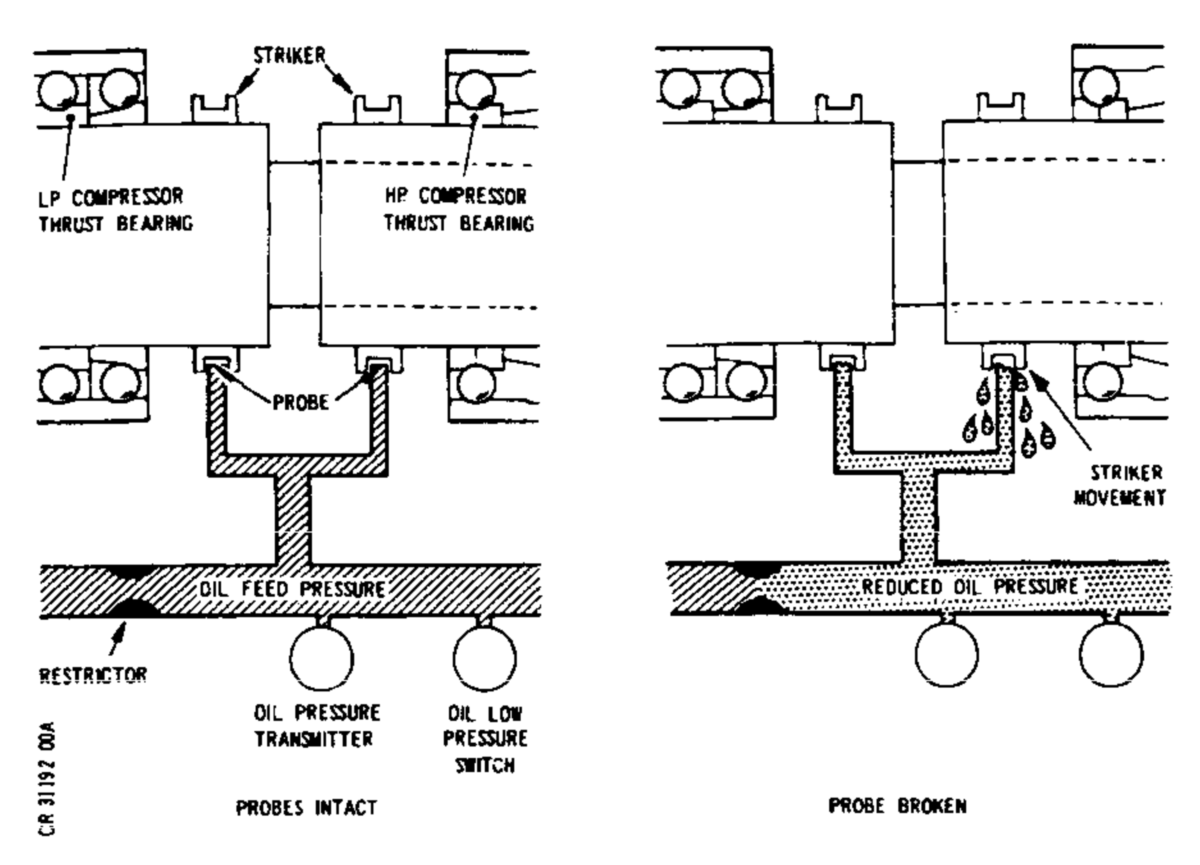
From the outlet connection on the gearbox, oil is delivered rearward via the external feed tubes to the HP and LP turbine bearings. A portion of the LP turbine bearing pressure feed oil supply is used to lubricate the LP shaft signal system operating mechanism.

Pressure oil feed tubes from the pump outlet connection, feed oil forward to the HP and LP compressor thrust bearings and LP compressor front bearing. A restrictor introduced by S.B.OL.593-72-8562-146, is located in the thrust bearing feed tube, external to internal tube connection, to control the oil flow rate.

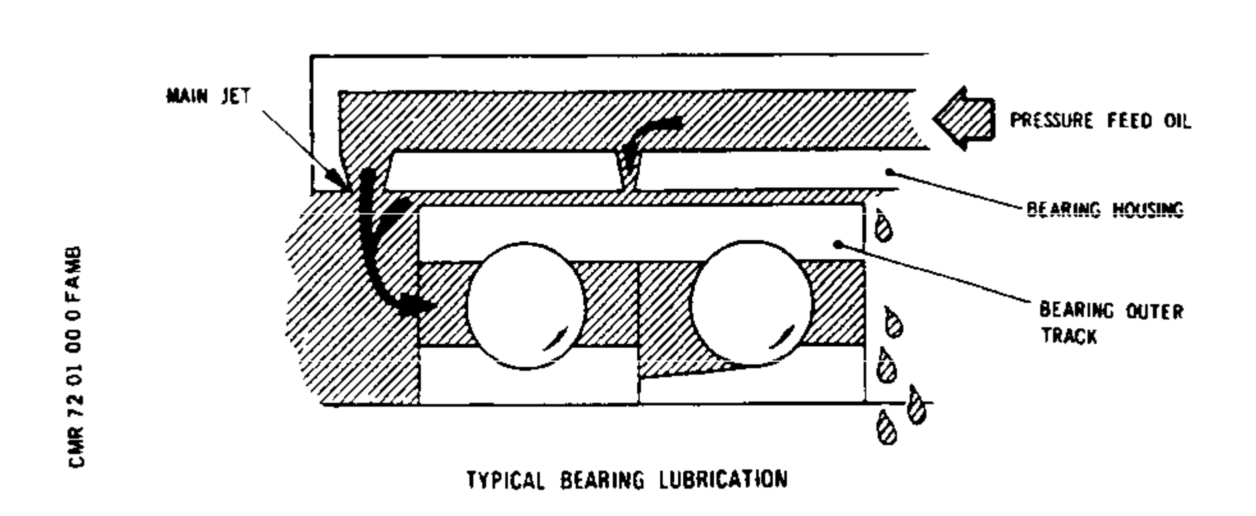
Each of the five bearings supporting the HP and LP rotating assemblies floats on a film of pressure oil when the engine is running. Internal tubes and drillings convey the oil to two jets at each bearing housing. Oil sprayed onto the front of the bearing from the larger jet flow rearwards and around the bearing before draining to the bottom of the bearing compartment. Oil from the smaller jet flows around the outer surface of the bearing outer track and centralizes the bearing in its housing.

OIL LOW PRESSURE WARNING SWITCH (79-00-00)
OIL PRESSURE TRANSMITTER (79-00-00)
LP COMPRESSOR SHAFT SIGNAL GENERATING MECHANISM
CR 31178/00C
FAILURE WARNING PROBES
LP COMPRESSOR FRONT BEARING
HP TURBINE BEARING
LP TURBINE BEARING
LP COMPRESSOR THRUST BEARING
HP COMPRESSOR THRUST BEARING
RESTRICTOR (S.B.72-146)
CMR 72 01 00 0 FAMA
MAIN OIL PUMP
PRESSURIZING VALVE
PRESSURE PUMP
TO GEARS AND BEARINGS
PERMANENT BLEED TO OIL RETURN SYSTEM
RIGHT HAND GEARBOX
LEFT HAND GEARBOX
RELIEF VALVE

Oil Pressure System (Diagrammatic)
(Sheet 1 of 2)
R Figure 007



THRUST BEARINGS FAILURE WARNING SYSTEM



TYPICAL BEARING LUBRICATION

Oil Pressure System (Diagrammatic)
(Sheet 2 of 2)
R Figure 007

A connection on the HP and LP compressor thrust bearings external feed tube diverts some of the oil flow through an external tube to the inlet connection on the right-hand gearbox. From the inlet connection, passages within the gearbox direct the oil through a filter, and restrictor to the jets from where it is sprayed over the gears and bearings. One jet directs oil to the integrated drive generator (IDG) input shaft bearing located in the IDG adapter. A seal prevents engine system oil passing beyond the bearing and a further oil seal isolates the IDG oil system as described in 24-11-11. The space between the two seals drains into the seal failure drains system described in 71-79-00. Oil is ducted to the air starter via the hollow drive shaft to maintain a level of oil in the starter gearbox and sump. A shaft seal prevents loss of oil past the starter turbine bearing. A seal failure would allow engine oil to pass into the drains system. All accessory splined drives are oil lubricated.

To assist in priming during engine starting and to assist recovery of pump output in the event of negative G conditions, a permanent oil bleed through a restrictor from the pump delivery into the scavenge return is provided.

The pressurizing valve prevents excessive oil being retained in the bearing chambers after engine shut-down. During deceleration on shut-down, the valve closes to cut-off the oil supply into the system. Under these conditions, the decreasing oil output from the pressure pump passes via the permanent bleed into the scavenge return.

To give warning of excessive movement of the HP and LP compressor thrust bearings, two sealed probes, containing oil taken via a restrictor from the oil feed passageway supplying the thrust bearing jets, are positioned close to the bearings. Deterioration of a bearing causes a striker to move axially, break the end of the probe and allow oil to flow out freely. This then causes an instant drop in oil pressure, downstream of the restrictor, that is sensed by the pressure transmitter and low oil pressure switch installed in the system (Ref. 79-00-00).

The thermometer installed in the oil feed tube to the HP turbine bearing senses the oil inlet temperature for comparison with the oil outlet temperature, sensed by the thermometer located in the bearing oil scavenge tube. An excessive temperature difference will activate captions and warnings in the aircraft flight compartment as described in 77-20-00.

R 10. <u>Operation of Engine Oil Scavenge System</u> (Ref. Fig.008)

After lubricating the bearings of the engine rotating assemblies, oil drains to the bottom of the four bearing compartments. Oil draining into the compartment of the HP and LP compressor thrust bearings continues into the pulse probe drive and housing sump.

Separate scavenge pumps in the main oil pump assembly draw oil from the LP turbine bearing compartment, the HP turbine bearing compartment, the pulse probe and drive housing sump and the LP compressor front bearing compartment.

The scavenge oil is conveyed from the bearing compartments and the pulse probe drive housing by scavenge tubes to the main oil pump. The oil from each source passes through a separate filter in the direction shown in illustration
R (Ref. Fig.009) to its related scavenge pump. The scavenge oil flow from each of the pumps is delivered to the one outlet connection from where it passes via the cooler to one tank.

Oil from the gears and drives of the right-hand gearbox, including the air starter, IDG bearing and the accessory drives splined shafts, drains to the bottom of the gearbox case. The gearbox mounted scavenge pump draws the oil through the scavenge filter and delivers it to an outlet connection on the front face of the gearbox from where it is returned externally, direct to the oil tank.

Pressurizing air and lubricating oil, from the LP and HP compressor thrust bearings, passes from the bearing chambers into the intermediate case and on into the pulse probe drive and housing. To assist in venting the thrust bearings, a two-piece vent/oil return tube connects the pulse probe drive and housing into the oil cooler to tank return tube. The pressurizing air, which has a tendency to separate from the oil, is conveyed through the tubes to the oil tank where it is vented via the oil tank venting system. The oil is drawn from the pulse probe drive and housing by the scavenge pump.

The probe of the magnetic plug installed at the base of the scavenge filter protrudes into the scavenge oil flow and attracts and retains any ferrous metal particles carried by the oil. The magnetic plug can be removed for inspection/ check when required. The spring-loaded, self-sealing valve in the drain valve body closes as the magnetic plug is removed and retains the oil in the gearbox during a plug removal.

CR 31181/008

LP COMPRESSOR FRONT BEARING

HP COMPRESSOR THRUST BEARING

LP COMPRESSOR SHAFT SIGNAL GENERATING MECHANISM

LP COMPRESSOR THRUST BEARING

HP TURBINE BEARING

LP TURBINE BEARING

PULSE PROBE DRIVE AND HOUSING SUMP

LEFT HAND GEARBOX

MAIN OIL PUMP

SCAVENGE PUMP

TO OIL COOLER

SCAVENGE PUMP

RIGHT HAND GEARBOX

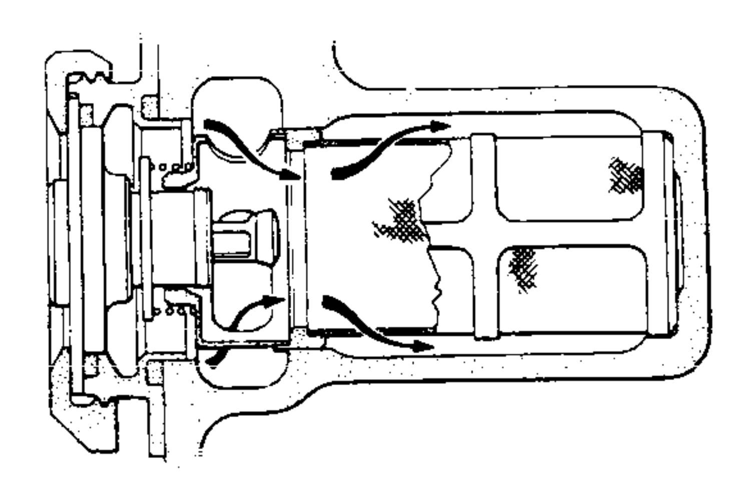
TO OIL TANK

CMR 72 01 00 0 GAMO

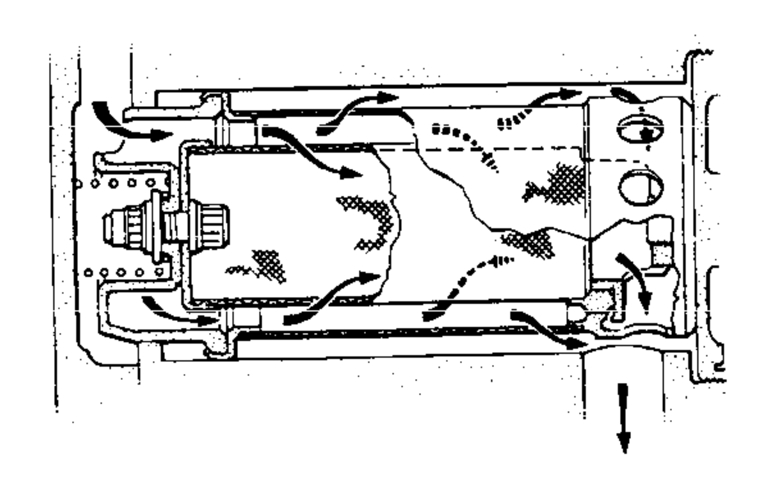
Engine Oil Scavenge System (Diagrammatic)
Figure 008

R

CR 34799/00A



TYPICAL OIL FLOW THROUGH SINGLE ELEMENT FILTER



TYPICAL OIL FLOW THROUGH DOUBLE ELEMENT FILTER

CMR 72 01 00 0 HAMO

Typical Oil Flow through Single and
Double Element Filters
R Figure 009

ENGINE LUBRICATION SYSTEM - TROUBLE SHOOTING

1. General

A. Due to the large number of oil leak paths the Olympus engine is known for the 'oily' nature of engine and engine bay. This leakage contributes to the overall oil consumption of the engine.

B. In order to monitor engine oil consumption and thus keep it under control, a monitoring procedure has been introduced. The front of the technical log contains three pages (Figure 101) for recording the data. The following points should be noted:

(1) The heavy line across the consumption rate calculator chart is drawn along the line equating to 2 US qts/hr and should be used as a guide, i.e. if the consumption falls above the line, both limits are satisfied. If the consumption falls below the line check maximum allowable consumption rate.

(2) The information included in para.2 - Oil System Trouble Shooting should be taken into account when considering high oil consumption.

(3) In order to maintain an oil consumption history of the engines at least ONE COMPLETED sheet must be kept in the log.

(4) When determining if an engine has oil consumption in excess of the limit, the individual sector oil consumptions should be considered separately and not averaged as has been the practice in the past. The higher limits for overseas stations are to enable an aircraft to complete its trip and thus return to base without causing an unnecessary delay if the source of the oil leak cannot be found.

(5) If at an overseas station the consumption exceeds the stated limit and troubleshooting reveals no source of oil loss, it may be considered acceptable to release the engine but LHR must be contacted and the following information will be required:-

(a) Oil consumption rate - the consumption rate over the last six sectors.

(b) Any relevant technical log entries.

(c) Proposed sector lengths (chock to chock).

(d) Oil contents loss versus mission profile, i.e. was oil lost during last half of supersonic cruise etc. This will involve talking to the crew for information.

(e) Details of the results of any troubleshooting carried out.

After consideration of the above, a decision will be made at LHR as to whether the aircraft may proceed. This decision will take into account that an extra two US quarts can be added to the oil tank.

CAUTION: AN EXTRA 2 US QUARTS MAY ONLY BE ADDED AFTER DISCUSSION WITH LHR.

(6) If a step change of over 1.25 US quarts/hr has occurred over the last sector but the overall consumption is within limits, it will be necessary to determine from the crew if the oil loss occurred uniformly over the whole sector or just a part of the sector. If the loss was uniform over the whole sector, the aircraft may proceed without rectification.

(7) If an extra 2 US quarts is added to the oil tank the following action must be taken.

(a) NTC raised stating that extra 2 US quarts is to be added at each station.

(b) ADD raised for rectification action to be taken at LHR.

(c) Station Engineer/Supervisor at next station should action oil consumption record as follows:

Chocks Sector Time (Hrs)	Oil Uplifts US Qts No.3	Oil Consumption US Qts/Hour No.3
4	8 (+2) i.e. 10 US Qts total uplift	2 (2.5)

i.e. Both rates should be calculated. Consumption

should continue to be monitored on RATE WHICH INCLUDES EXTRA 2 US QUART UPLIFT. If consumption rate continues to deteriorate over inbound sectors to LHR, LHR must be re-contacted.

2. Oil System Troubleshooting for High Oil Consumption

A. General

R (1) Refer to Chapter 71-00-00 Inspection/Check - Action to be taken to reduce the risk of oil pressure filter blockage due to the shedding of carbon and/or anti-wear additive.

(2) There is a deviation in oil tank contents when the engine is static and when it is running. The deviation of approx. 1.5 to 2 US quarts is downward during engine start and upward during engine shut down.

(3) The oil contents gauge will not indicate below 4 US quarts, i.e. with 2 US quarts remaining in the oil tank, the gauge will indicate 4 US quarts. Once the gauge has reached 4 US quarts, there is approx. 4 US quarts remaining in the tank before the low oil pressure warning light will start to flicker.

(4) When an engine is shut down in flight, during windmilling operation approx. 2 US quarts are pumped from the gearboxes into the oil tank. In order to replenish the oil tank correctly, the tank must first be topped up to the normal full position and then run at idle for 5 minutes. The engine should then be shut down and after rotation has stopped the tank re-topped up to normal full level. It is important to do this when considering oil consumption rates for an engine which has been shut down due to loss of oil.

OLYMPUS 593 - OIL CONSUMPTION MONITORING INSTRUCTIONS AND INFORMATION SHEET

USABLE ENGINE OIL CAPACITY IN US QUARTS - 12
NORMAL OIL TANK CAPACITY IN US QUARTS - 14
OIL CONTENTS GAUGE STOPS READING AT 4 US QUARTS

ENGINEER OFFICER

ON COMPLETION OF SECTOR

1. ENTER DATE, SECTOR DETAILS AND SECTION TIME

   (CHOCK TO CHOCK)

ON COMPLETION OF TRIP

1. DURING LAST SECTOR INTO LHR ASSESS OIL CONSUMPTION RATE OVER THE FIVE PREVIOUS SECTORS. IF ANY ENGINE HAS APPARENT AVERAGE CONSUMPTION IN EXCESS OF 1.5 US QTS PER HOUR OR IF THERE HAS BEEN A SIGNIFICANT INCREASE IN CONSUMPTION RATE, RAISE A SECTOR DEFECT LOG ENTRY

STATION ENGINEER/SUPERVISOR

AS SOON AS PRACTICABLE AFTER AIRCRAFT ARRIVAL

1. RECORD OIL UPLIFT FOR EACH ENGINE IN US QTS IN 'A'.
2. ENTER CALCULATOR TABLE WITH SECTOR TIME AND OIL UPLIFT EXTRACT OIL CONSUMPTION RATE FOR EACH ENGINE AND RECORD IN APPROPRIATE COLUMN OF SECTION 'B' IN US QTS PER HOUR
3. COMPARE OIL CONSUMPTION RATES FOUND IN PARA.2 WITH THOSE RECORDED FOR PREVIOUS SECTORS.
4. MAXIMUM ALLOWABLE OIL CONSUMPTION RATES

   A. DESPATCH FROM LHR - 2.0 US QTS PER HR

      DESPATCH FROM OVERSEAS STATION - 2.0 US QTS PER HR

   ANY ENGINE EXHIBITING AN OIL CONSUMPTION RATE IN EXCESS OF THE ABOVE LIMITS:

   i) REFER TO MM REFERENCE 72-01-00 P/B 101 ON OIL CONSUMPTION

   ii) IF NO SOURCE OF OIL LOSS CAN BE FOUND CONSULT LHR.

   B. A STEP CHANGE IN OIL CONSUMPTION OVER LAST SECTOR OF 1.25 US QTS PER HOUR OR MORE, REFER TO MM REFERENCE 72-01-00 P/B 101 ON OIL CONSUMPTION
5. IN THE EVENT OF AN ENGINE CHANGE THE RESPONSIBLE SUPERVISOR SHOULD ENTER THE WORDS "ENGINE CHANGE" AND THE DATE IN THE APPROPRIATE OIL CONSUMPTION RATE COLUMN OF SECTION 'B'.

R

Oil Consumption Monitoring (Sheet 1)
Figure 101

B. Procedure For Oil System Troubleshooting

If an engine exhibits a high oil consumption, the following procedure should be carried out to determine source of oil loss/leakage.

CAUTION: WHEN TROUBLESHOOTING FOR HIGH OIL CONSUMPTION, REMEMBER THERE MAY BE MULTIPLE SOURCES OF LEAKAGE. THEREFORE FOLLOWING RECTIFICATION ACTION, THE ENGINE'S OIL CONSUMPTION TREND MUST BE CONFIRMED AS SATISFACTORY. AN ADDITIONAL TWO QUART UPLIFT MUST BE MAINTAINED FOR A FURTHER SIX SECTORS UNTIL THE LEVEL IS CONFIRMED.

(1) Examine bay and engine for obvious signs of oil leaks.

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CMR 72 01 00 1 AAMB

A/C REG ....

E/O OPERATING SECTOR				STATION ENGINEER/SUPERVISOR							
DATE	SECTOR		CHOCKS SECTOR TIME	A. OIL UPLIFT U.S. QTS				B. OIL CONSUMPTION RATE U.S. QTS PER HOUR			
	FROM	TO		#1	#2	#3	# 4	#1	#2	#3	#4

Oil Consumption Monitoring For A6223
(Not to Scale) (Sheet 2)
Figure 101

CMR 72 01 00 1 AAMC

SECTOR TIME (CHOX TO CHOX) HRS

OIL UPLIFT - US QTS	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75	4	4.25	4.5	4.75	5
0.5	·5	·4	.33	.28	.25	.22	.2	.18	.16	.15	.14	.13	.125	.12	0.11	.105	.1
1	1.0	.8	.66	.56	.5	.44	.4	.36	.32	.3	.28	.26	.26	.235	.22	.21	.2
1.5	1.5	1.2	1.0	.85	.75	.66	.6	.54	.48	.45	.42	.39	.36	.35	.33	.32	.3
2	2.0	1.6	1.3	1.1	1.0	.88	.8	.72	.64	.6	.56	.52	.5	.47	.44	.42	.4
2.5	2.5	2.0	1.6	1.4	1.2	1.1	1.0	.9	.8	.76	.71	.66	.62	.58	.55	.52	.5
3	3.0	2.4	2.0	1.71	1.5	1.3	1.2	1.09	1.0	.92	.85	.8	.75	.70	.66	.63	.6
3.5	3.5	2.8	2.3	2.0	1.75	1.5	1.4	1.25	1.16	1.07	1	.93	.87	.82	.77	.73	.7
4	4.0	3.2	2.6	2.2	2.0	1.7	1.6	1.4	1.3	1.2	1.1	1.06	1.0	.94	.88	.84	.80
4.5	4.5	3.7	3.0	2.5	2.2	2.0	1.8	1.6	1.5	1.4	1.3	1.2	1.1	1.06	1.0	.94	0.9
5	5.0	4.0	3.2	2.8	2.4	2.2	2.0	1.8	1.6	1.5	1.4	1.3	1.2	1.17	1.11	1.05	1.0
5.5	5.5	4.4	3.6	3.1	2.7	2.4	2.2	2.0	1.8	1.08	1.56	1.46	1.37	1.3	1.22	1.15	1.1
6	6.0	4.8	4.0	3.42	3.0	2.66	2.4	2.18	2.0	1.84	1.71	1.6	1.5	1.41	1.33	1.26	1.2
6.5	6.5	5.2	4.33	3.71	3.25	2.88	2.6	2.36	2.16	2.0	1.85	1.73	1.62	1.53	1.45	1.36	1.3
7	7.0	5.6	4.66	4.0	3.5	3.11	2.8	2.54	2.33	2.15	2.0	1.86	1.75	1.64	1.55	1.47	1.4
7.5	7.5	6.0	5.0	4.3	3.75	3.3	3.0	2.73	2.5	2.31	2.14	2.0	1.87	1.76	1.67	1.58	1.5
8	8.0	6.4	5.33	4.57	4.0	3.55	3.2	2.9	2.66	2.46	2.28	2.13	2.0	1.88	1.77	1.68	1.6
8.5	8.5	6.8	5.67	4.85	4.25	3.77	3.4	3.1	2.83	2.61	2.42	2.26	2.13	2.0	1.88	1.78	1.7
9	9.0	7.2	6.0	5.14	4.5	4.0	3.6	3.27	3.0	2.77	2.57	2.4	2.25	2.11	2.0	1.89	1.8
9.5	9.5	7.6	6.33	5.43	4.75	4.22	3.8	3.45	3.16	2.92	2.71	2.53	2.375	2.23	2.11	2.0	1.9
10	10.0	8.0	6.66	5.71	5.0	4.44	4.0	3.63	3.33	3.07	2.85	2.66	2.5	2.35	2.22	2.1	2.0
11	11.0	8.8	7.33	6.28	5.5	4.88	4.4	4.0	3.66	3.38	3.14	2.93	2.75	2.58	2.44	2.31	2.2
12	12.0	9.6	8.0	6.85	6.0	5.33	4.8	4.36	4.0	3.69	3.42	3.2	3.0	2.82	2.66	2.52	2.4
13	13.0	10.4	8.66	7.42	6.5	5.77	5.2	4.72	4.33	4.0	3.7	3.46	3.25	3.05	2.88	2.73	2.6
14	14.0	11.2	9.33	8.0	7.0	6.22	5.6	5.09	4.66	4.3	4.0	3.73	3.5	3.29	3.11	2.94	2.8

Olympus 593 - Oil Consumption Rate
Consumption Chart (Sheet 3)
Figure 101

EFFECTIVITY: ALL

BA

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(2) Remove oil pressure filter and No.4 bearing scavenge filter. Examine for carbon contamination. If contamination is found refer to para. 2.C.(12). If no contamination is found proceed as below.

(3) If no obvious oil leaks can be found and there is no carbon in the filters, clean engine thoroughly using a suitable cleaning agent, e.g. white spirit or Genklene.

(4) Disconnect all pipes except oil tank vent which feed the oil tank vent and overboard drains seal plate. Place ends of pipes in plastic bags. Refer to 71-79-00 and 71-00-24, Troubleshooting for identification.

(5) Disconnect first stage pump and fuel control unit/second stage pump fuel gland seal drain pipes at suitable locations. Place ends of pipes in plastic bags.

(6) Run engine at idle for 5 min and check for signs of oil leaks or excessive venting from the No.2 and 3 bearing cold vent, No.4 and 5 bearing cold vent, No.4 and 5 bearing and G-labyrinth hot vents (LH and RH side of engine).

(7) If no signs of oil leaks or excessive venting can be found, run engine as follows:

Idle	-	5 min
101%	-	2 min
Idle	-	30 s
T/O	-	30 s
101%	-	2 min
Idle	-	Recheck for oil leaks.

(8) If oil wetness is observed in an area but the exact location of leak cannot be found, thoroughly wash area down, apply French chalk/Checkmor developer and repeat steps (6) and (7) if necessary. Check for oil staining of French chalk/developer.

B (9) If there are still no signs of oil leaks or excessive
B venting after running engine as per para. B.(7) above,
B suspect internal distress of the Fuel Cooled oil
B cooler. In this event it is recommended that an oil
B system fuel contamination check be carried out (Ref.
B 79-00-02, Inspection/Check).

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C. Highlight Areas for Oil Leakage

Listed below are areas which in the past have caused high oil consumption. These are in order of occurence rate.

	Sympton	Cause	Action
(1)	Engine oil leaking from RH gearbox R QAD. Oil runs down curved upper surface of gearbox and then around curved end finally dripping from flat lower face.	Wear of sealing surfaces and seal due to relaxation of multi-start thread wear.	Bays 2 & 4 Retorque QAD and re-check for leaks. If not cured, reject engine. Bays 1 & 3 Retorque QAD. Due to inaccessibility, it is acceptable to relock QAD bolt with locknut instead of locking wire. NOTE: It will probably be necessary to remove IDG for access. If leak not cured, reject engine.
R (2)	Engine oil leaking past IDG gland seal and overboard via engine oil drains seal plate.	Deteriorated IDG input shaft gland seal.	Replace the IDG. Where this is not possible ex LHR the drains may be blanked (Ref. 24-11-11, Servicing, para. 5) for return to LHR only. Blanked IDG's are NOT to be interchanged between engines.
(3)	(a) Oil draining out of No.1 bearing vent with engine running.	(a) Fractured No.1 bearing scavenge pipe within No.1 bearing housing.	(a) Change engine.

	(b) as (3) (a).	(b) No.1 bearing scavenge pipe blocked with carbon. (Caused by anti-ice valve failing in supersonic cruise).	(b) Check No.1 bearing scavenge filter for carbon contamination/ blockage. Remove accessible No.1 bearing scavenge pipes and check for blockage. Blow down scavenge pipe in IGV strut with air line. If oil draining persists change engine.
(4)	Oil venting from the oil tank overboard vent.	Defective air/oil separator pack in the oil tank.	Fit separator pack to P/No.B495701 SB.OL.593-79-79 CM 45149. NOTE: On positions 2 and 4 it will be necessary to drop engine for access.
(5)	Leaking oil fill/ drain HTE coupling on oil tank.	Sealing surfaces contaminated with dirt.	Either replace HTE coupling or clean with white spirit.
(6)	Oil draining out of the starter overboard drain.	Starter gland seal failure.	Replace starter.
(7)	Oil comes out of the fuel 'press to test' when pressed.	Either FCU/SSP or FSP gland seal failures.	Break down gland seal drain pipes to determine which component is defective.
(8)	Oil running down oil tank casing or back of LP compressor casing behind tank.	Cracked oil tank.	Replace oil tank.
(9)	HP spool hand turning adaptor leaking.	Loose bolts or damaged gasket.	Rectify as necessary.

(10)	Excessive venting from No's 2 & 3 bearing cold vent.	Worn labyrinths No's 6 to 11.	Fit No.2 & 3 bearing restrictor mod CM 45188. IMPORTANT: MOD ONLY TO BE FITTED WITH APPROVAL OF PROPULSION ENGINEERING. Engine drop required on engines 1 & 3 to fit restrictor.
(11)	Oil leaking from FCU QAD.	Wear of sealing surfaces and seal.	Retorque QAD and recheck for leaks. R If not cured R replace seal.
(12)	Excessive quantities of carbon in pressure or scavenge filters may be associated with high oil consumption and/or fluctuating oil pressure.	Separation of carbon flakes from casings and bearing housings.	1. Remove and inspect all other scavenge filters for contamination. 2. Clean and refit all filters. 3. Run engine at idle for 5 min. 4. Re-inspect all filters that were originally contaminated. 5. Repeat 1 thru 4 until no further contamination is found. 6. Contaminated filters to be rechecked at next LHR stop.

ENGINE LUBRICATION SYSTEM - SERVICING

1. General

This chapter gives the procedures for draining the engine oil from the gearboxes in paragraph 2. Procedures for removal and installation of magnetic plugs and pressure and scavenge filters for inspection purposes are given in paragraphs 3 and 4 respectively.

Details for draining and filling the oil system complete and draining the oil tank only are contained in 79-00-01 and 79-10-00 respectively. Oil tank replenishing and oil consumption monitoring procedures are detailed in 12-13-79.

Servicing procedures are not applicable to the jet strainer/ filters located in the gearboxes.

CAUTION: A DRY CYCLE OR IDLE LEAK CHECK MAY NOT CONFIRM THAT A JOINT IS LEAK FREE.

Following disturbance to the filters, drain plugs, MCD's or hydraulic pipe connections, it is necessary to carry out a ground run (Ref. 71-00-00, Adjustment/Test) and check for oil leakage.

2. Oil Draining

A. General.

When only one gearbox requires to be drained, comply with the procedure detailed in either paragraph D or paragraph E appropriate to the gearbox affected and then complete the servicing procedure.

B. Tools and Equipment.

Drain tube, for drain valves in
R gearboxes (Pre.SB.72-9036-419) PE.29023
R (SB.72-9036-419) S3S.20590000

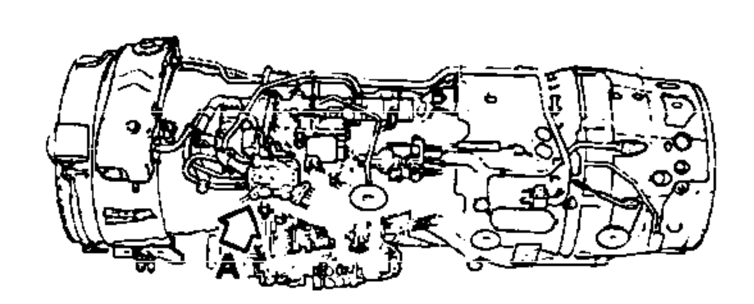
C. Prepare to Drain Oil System.

(1) Open engine bay front lower door (Ref.71-00-00, Servicing).

D. Drain Oil from Left-hand Gearbox (Ref.Fig.301 or 301A).

(1) Position container below main oil pump.

CR 31211/00B
BS00000026/3



LP AND HP COMPRESSOR THRUST BEARINGS
AND GEARBOX SCAVENGE FILTER LOCATION

MAIN OIL PUMP

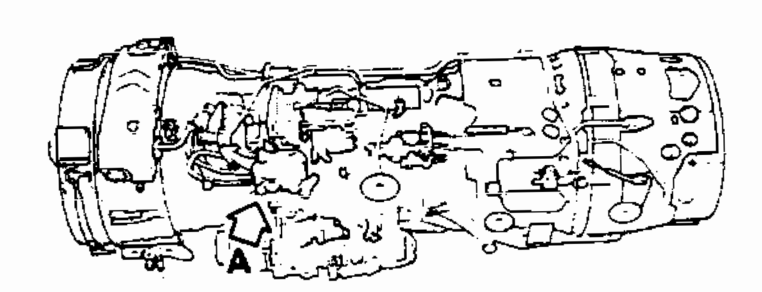
DRAIN TUBE

A

R MAGNETIC PLUG (REMOVED)

Left-hand Gearbox Oil Draining
(Pre SB.OL.593-72-9036-419)
Figure 301

CR 36656/00B
BS0002650/4



L.P. AND H.P. COMPRESSOR THRUST BEARINGS
AND GEARBOX SCAVENGE FILTER LOCATION

MAIN OIL PUMP

R O-SEAL

DRAIN TUBE

R MAGNETIC PLUG (REMOVED)

A

Left-hand Gearbox Oil Draining
(SB.OL.593-72-9036-419)
Figure 301A

(2) Remove the magnetic plug from the drain valve and body assembly installed at the LP and HP compressor thrust bearings and gearbox scavenge filter location.

CAUTION: USE ONLY THE APPROVED DRAIN TOOL.

(3) Direct drain tube end into container and screw drain adapter onto drain valve and body assembly. This action opens valve.

(4) When oil ceases to drain, remove drain tube. Measure and record quantity of oil drainage.

(5) Install the magnetic plug.

NOTE: A spring ring locking device housed in the drain valve body is effective during the final half turn of tightening of the magnetic plug.

(a) Apply lubricant A (Ref. 70-00-01, Servicing and Storage Materials) and screw the magnetic plug in drain valve and body assembly.

CAUTION: IT IS OF THE UTMOST IMPORTANCE TO ENSURE THAT ALL MAGNETIC PLUG ASSEMBLIES ARE FULLY TORQUE-TIGHTENED ON ASSEMBLY, ALSO, WHEN FITTING ASSEMBLIES MODIFIED TO SB.OL.593-72-9036-419 STANDARD A SERVICEABLE '0' SEAL MUST BE FITTED. FAILURE TO DO THIS CAN RESULT IN OIL LEAKAGE IN FLIGHT WHICH MAY NOT BE APPARENT DURING GROUND CHECKS/ RUNNING.

(b) Torque-tighten the magnetic plug to 30 lbf ft (40,7 N.m).

E. Drain Oil from Right-hand Gearbox (Ref. Fig.302 or 302A).

(1) Position container below right-hand gearbox oil scavenge filter location.

(2) Remove screwed magnetic plug assembly from the drain valve and body assembly installed at the right-hand gearbox oil scavenge filter location.

(3) Prepare the magnetic plug for inspection/check as detailed in paragraph 3.

CAUTION: USE ONLY THE APPROVED DRAIN TOOL.

(4) Direct drain tube end into container, remove cap from drain adapter then screw adapter into drain valve and body assembly. This action opens valve.

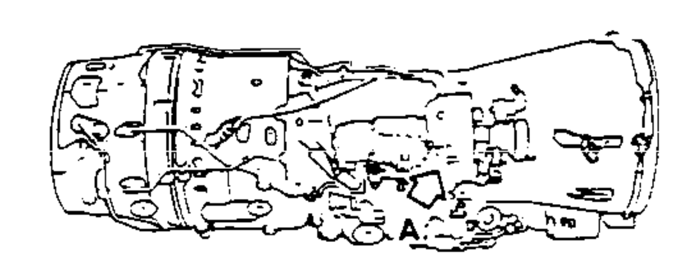
(5) When oil ceases to drain, remove drain tube. Measure and record quantity of oil drained.

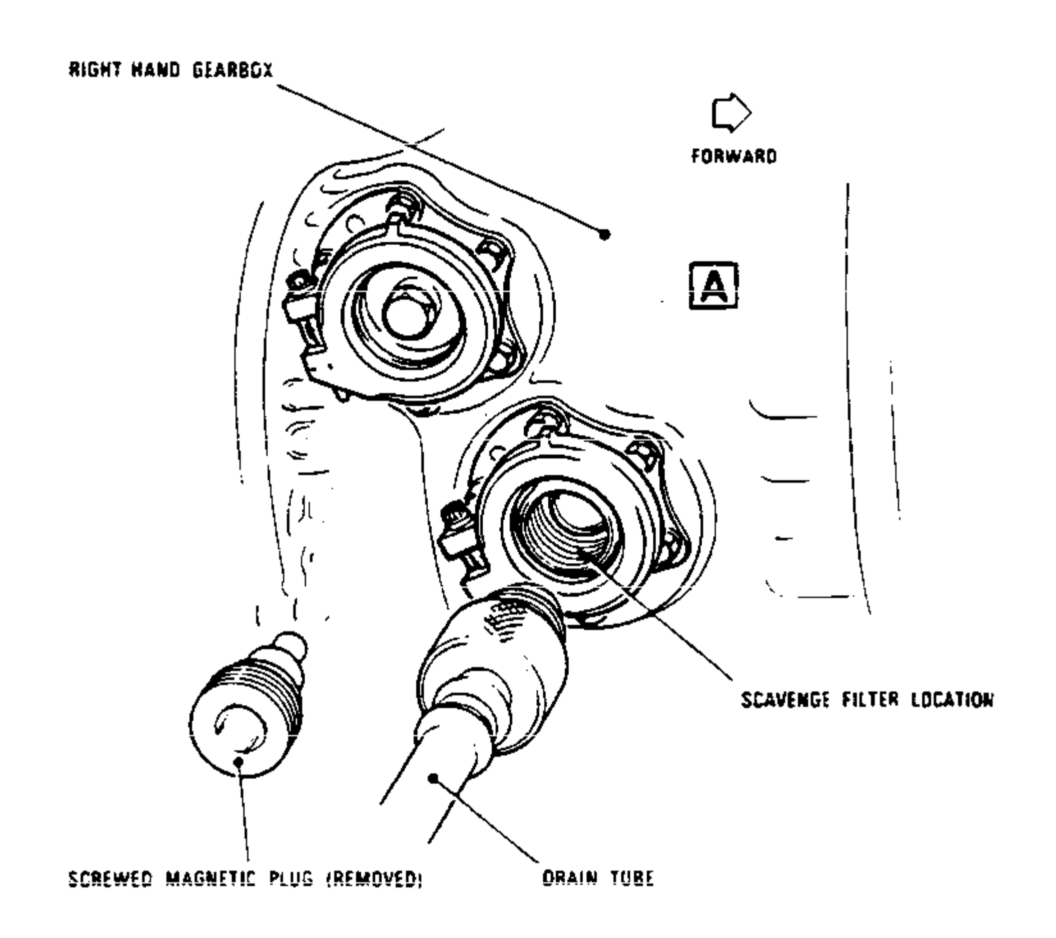
(6) Install magnetic plug assembly.

NOTE: A spring ring locking device housed in the drain valve body is effective during the final half turn of tightening of the magnetic plug.

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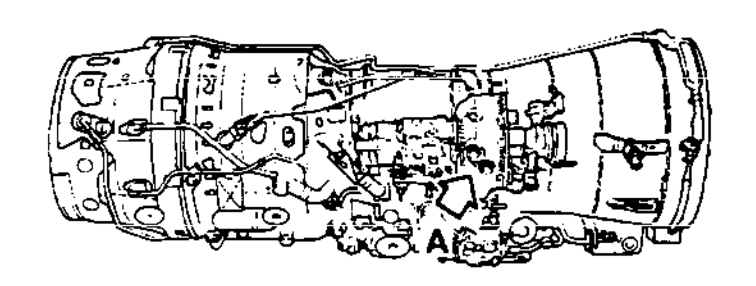


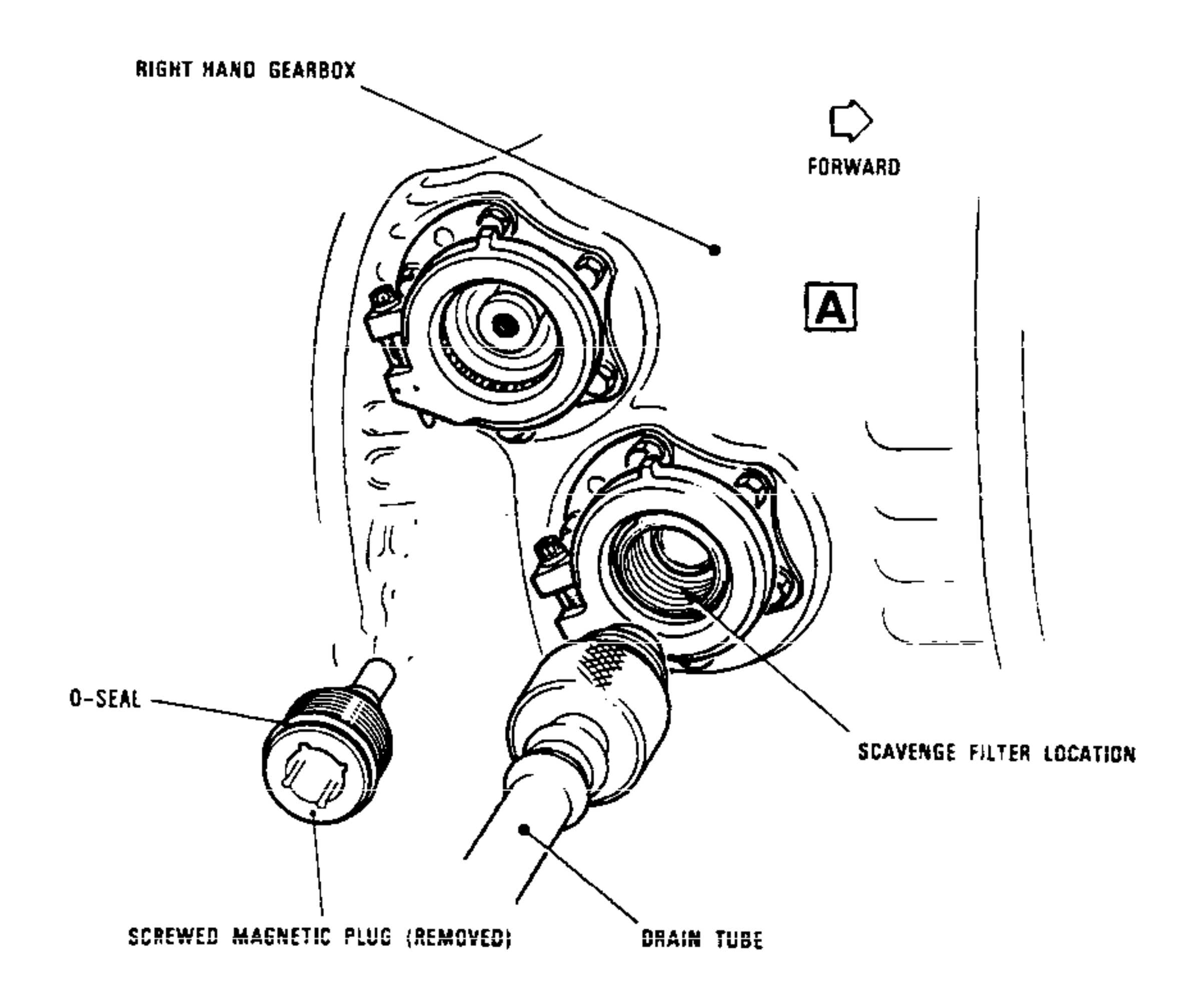


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R Right-hand Gearbox Oil Draining
(Pre SB.OL.593-72-9036-419)
Figure 302

CR 36658/008
BS0002652/2





R

Right-hand Gearbox Oil Draining
(SB.OL.593-72-9036-419)
Figure 302A

(a) Apply lubricant A and screw plug in drain valve and body assembly.

R CAUTION: IT IS OF THE UTMOST IMPORTANCE TO ENSURE THAT ALL MAGNETIC PLUG ASSEMBLIES ARE FULLY TORQUE-TIGHTENED ON ASSEMBLY, ALSO, WHEN FITTING ASSEMBLIES MODIFIED TO SB.OL.593-72-9036-419 STANDARD A SERVICEABLE '0' SEAL MUST BE FITTED. FAILURE TO DO THIS CAN RESULT IN OIL LEAKAGE IN FLIGHT WHICH MAY NOT BE APPARENT DURING GROUND CHECKS/ RUNNING.

(b) Torque-tighten plug to 30 lbf ft. (40 N.m).

F. Complete the Servicing Procedure.

(1) With the oil tank full (Ref.12-13-79) and the over-flow drain connection drain plug installed, add a quantity of oil to the tank equivalent to the amount drained during the removal procedures.

NOTE: If the oil tank was drained concurrent with gearbox draining, comply with the filling procedure given in 79-00-01, Engine Oil System Servicing.

(2) On completion of work, close engine bay door (Ref. 71-00-00, Servicing).

R 3. Magnetic Plug Assemblies (Ref. Fig. 303 or 303A and Fig.305)

A. General.

CAUTION: IT IS OF THE UTMOST IMPORTANCE TO ENSURE THAT ALL MAGNETIC PLUG ASSEMBLIES ARE FULLY TORQUE-TIGHTENED ON ASSEMBLY. FAILURE TO DO THIS CAN RESULT IN OIL LEAKAGE IN FLIGHT WHICH MAY NOT BE APPARENT DURING GROUND CHECKS/RUNNING.

R B NOTE: The fitment of engine oil magnetic plug assemblies are designated critical maintenance tasks. As such fitment is non-delegable and requires a duplicate inspection. The duplicate inspection must be completed simultaneously to ensure correct magnetic plug assembly and torque loading.

Magnetic plugs are installed in the following locations to monitor the condition of oil wetted components, with the plugs being colour coded for ease of identification as shown in Table A below.

Magnetic Plug Nomenclature	Colour	Location
Master	Blue	Return tube oil container
No.2 & 3 Bearing	Yellow	LH Gearbox scavenge filter
Scavenge	Plain	RH Gearbox scavenge filter

TABLE A

The No.2 and 3 Bearing Magnetic Plug may also be referred to as the Location or Thrust Bearing Magnetic Plug.

There are also magnetic plugs fitted at the LP turbine and HP turbine scavenge filter locations (Ref. Fig. 305) and in the Air Turbine Starter Unit (80-11-11) which shares its oil supply with the engine.

B. Remove Magnetic Plugs

Note: This procedure is applicable to all magnetic plug locations.

(1) Open engine bay front lower door (Ref. 71-00-00 Servicing).

(2) Wipe magnetic plug and surrounding area clean.

(3) Unscrew and remove magnetic plug ensuring that the self-sealing valve in drain valve has correctly seated. Take care that any debris adhering to the magnetic plug is not dislodged. (Ref. Fig. 303).

(4) Inspect magnetic plugs for any sign of abnormal wear deposits. Any such deposits should be reported to Development Engineering immediately (Ref. 72-01-00, Inspection/Check).

(5) Place a protective sleeve over the magnetic portion of the plug and place plug in appropriate location within an Engine Monitoring Section Magnetic Plug box.

(6) Ensure box is correctly labelled with aircraft registration and date and route to Engine Monitoring Section for routine inspection check.

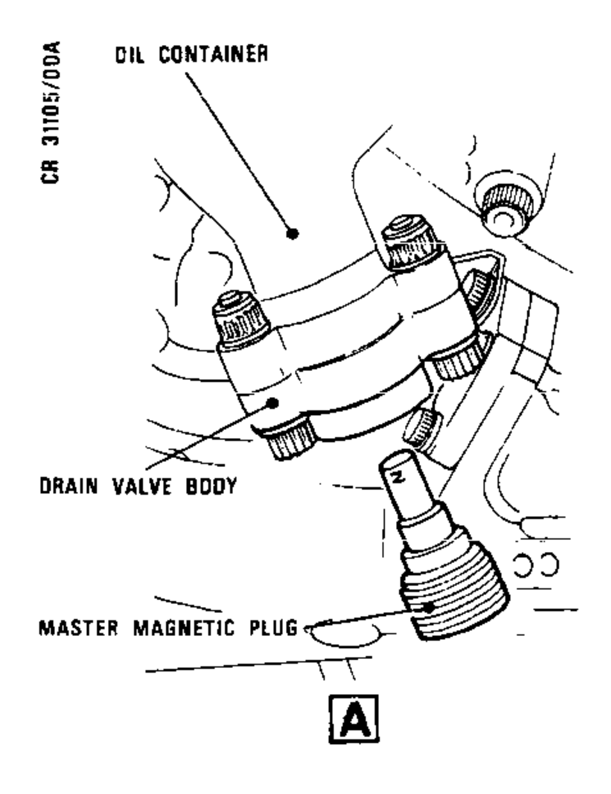
<u>CAUTION:</u> When handling magnetic plugs, ensure that they are isolated from ferrous metals and other magnetic plugs.

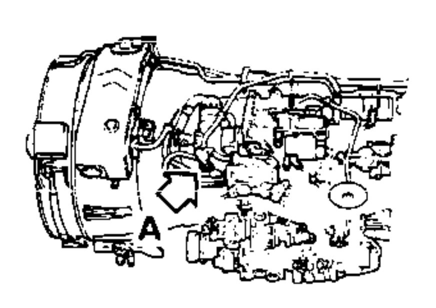
C. Install Magnetic Plugs

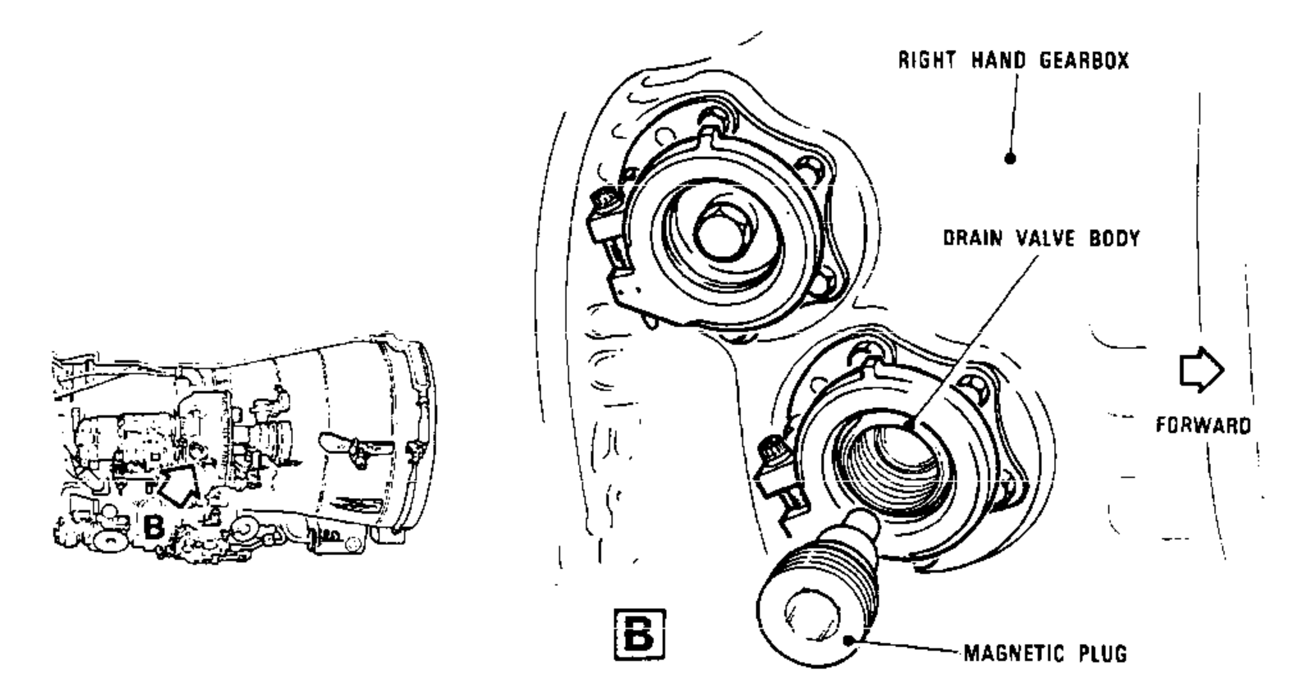
<u>CAUTION:</u> IT IS OF THE UTMOST IMPORTANCE TO ENSURE THAT ALL MAGNETIC PLUG ASSEMBLIES ARE FULLY TORQUE-TIGHTENED ON ASSEMBLY, ALSO, WHEN FITTING ASSEMBLIES MODIFIED TO SB.OL.593-72-9036-419 STANDARD A SERVICEABLE 'O' SEAL MUST BE FITTED. FAILURE TO DO THIS CAN RESULT IN OIL LEAKAGE IN FLIGHT WHICH MAY NOT BE APPARENT DURING GROUND CHECKS/RUNNING.

<u>NOTE:</u> A spring ring locking device housed in the drain valve body is effective during the final half turn of tightening of the magnetic plug.

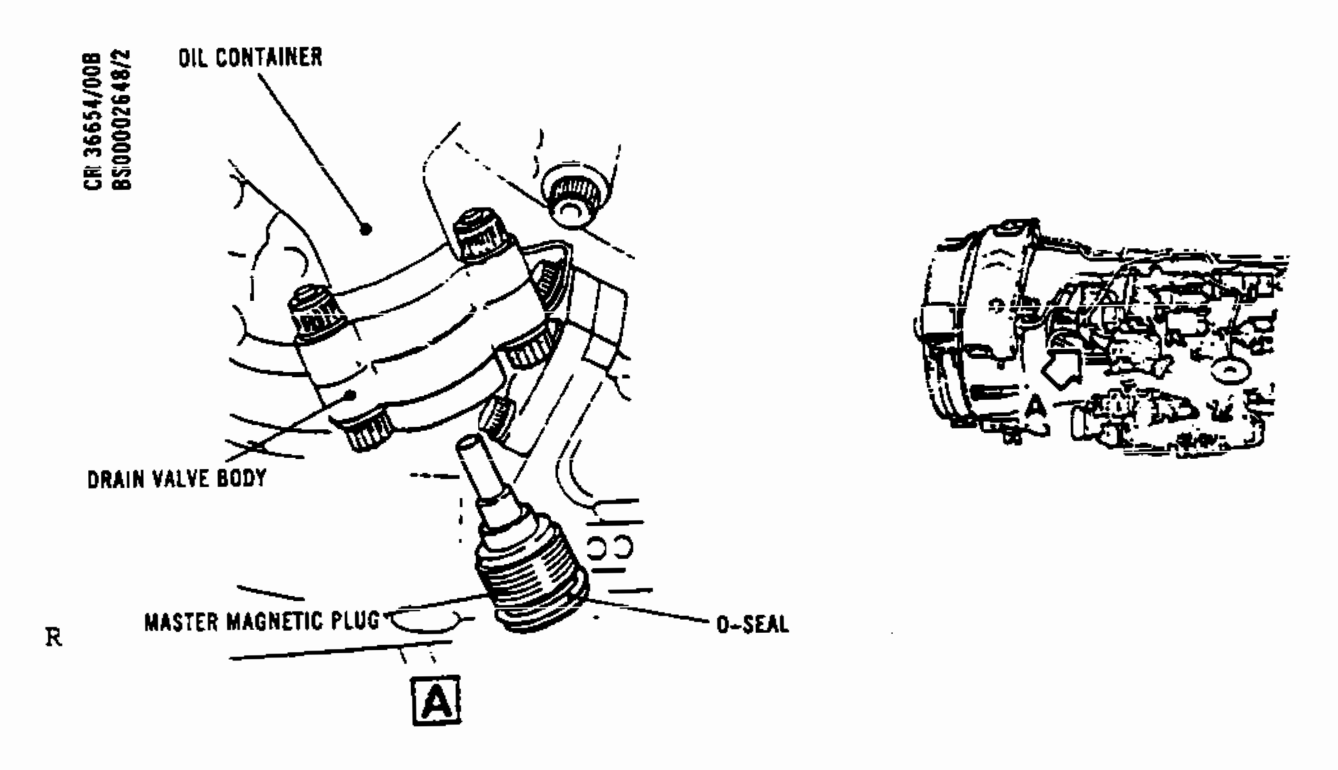
(1) Apply lubricant A (Ref. 70-00-01, Servicing and Storage Materials) to plug and screw plug into its location.



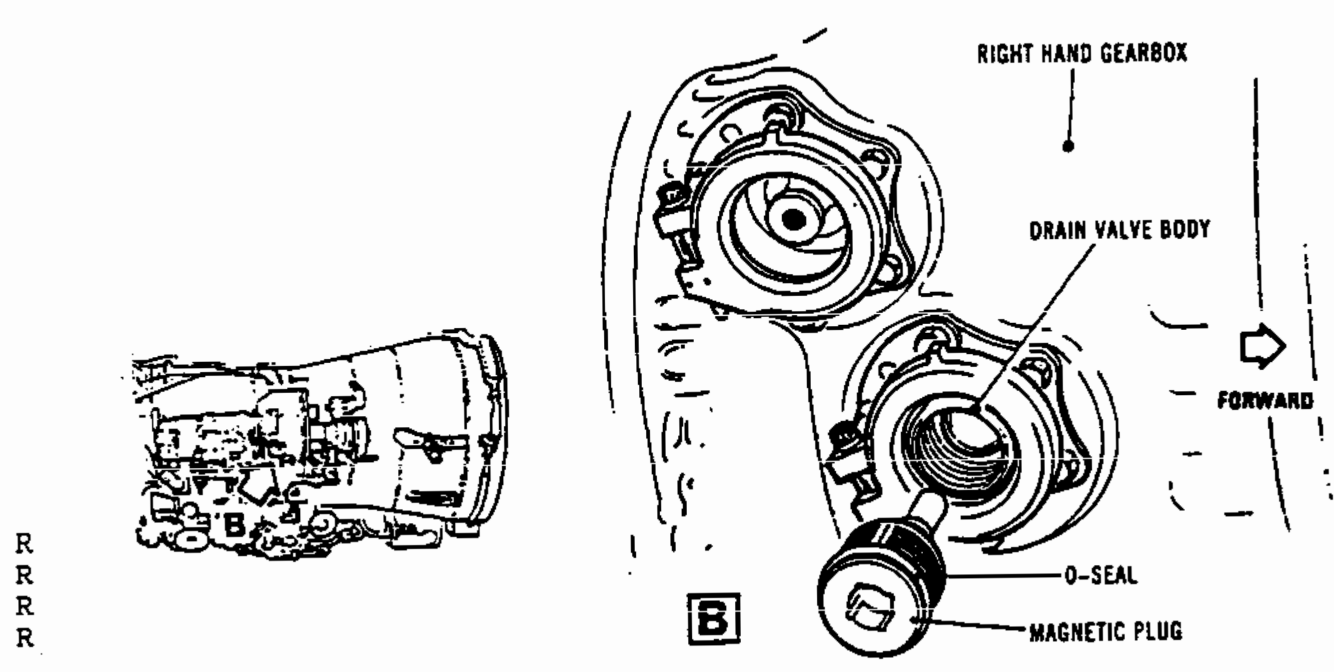




R Magnetic Plugs and Location Detail
(Pre SB.OL.593-72-9036-419)
Figure 303



R



R
R
R
R

Magnetic Plugs and Location Detail
(SB.OL.593-72-9036-419)
Figure 303A

R CAUTION: IT IS OF THE UTMOST IMPORTANCE TO ENSURE
R THAT ALL MAGNETIC PLUG ASSEMBLIES ARE
R FULLY TORQUE-TIGHTENED ON ASSEMBLY, ALSO,
R WHEN FITTING ASSEMBLIES MODIFIED TO
R SB.OL.593-72-9036-419 STANDARD A
R SERVICEABLE '0' SEAL MUST BE FITTED.
R FAILURE TO DO THIS CAN RESULT IN OIL
R LEAKAGE IN FLIGHT WHICH MAY NOT BE
R APPARENT DURING GROUND CHECKS/RUNNING.

B (2) Torque-tighten magnetic plug to 30 lbf. ft.

B CAUTION: Ensure that magnetic plug is not torqued
B above 30 lbf. ft. Shearing of the filter
B housing assembly locating pins may
B otherwise result.

B (3) Close engine bay front lower door (Ref. 71-00-00
B Servicing).

R

4. Filters

CAUTION: IT IS OF THE UTMOST IMPORTANCE TO ENSURE THAT ALL MAGNETIC PLUG ASSEMBLIES ARE FULLY TORQUE TIGHTENED ON ASSEMBLY. FAILURE TO DO THIS CAN RESULT IN OIL LEAKAGE IN FLIGHT WHICH MAY NOT BE APPARENT DURING GROUND CHECKS/RUNNING.

RB NOTE: The fitment of engine oil filters are designated
RB critical maintenance tasks. As such fitment is
RB non-delegable and requires a duplicate inspection. The
RB duplicate inspection must be completed simultaneously to
RB ensure correct filter assembly, torque loading and
RB locking.

A. General

(1) The following paragraphs detail the removal, preparation for inspection and installation of the pressure feed filters and scavenge filters. Paragraph D deals with the LP compressor front bearing scavenge filter, paragraph E with the three scavenge filters which are installed in a similar manner in the main oil pump, and paragraph F with the scavenge filter in the right-hand gearbox. The pressure filter of the right-hand gearbox is dealt with in paragraph G and the main oil pump pressure filter in paragraph H. Comply with paragraph C before commencing any filter removal.

(2) Immediately on removal of a filter assembly from its location, carry out a thorough visual inspection of the filter, assess the degree of contamination and then continue with the inspection/processing procedure detailed in 72-01-00, Inspection/Check. Oil flow directions through the filters are indicated in Figure 8 in 72-01-00, Description/Operation.

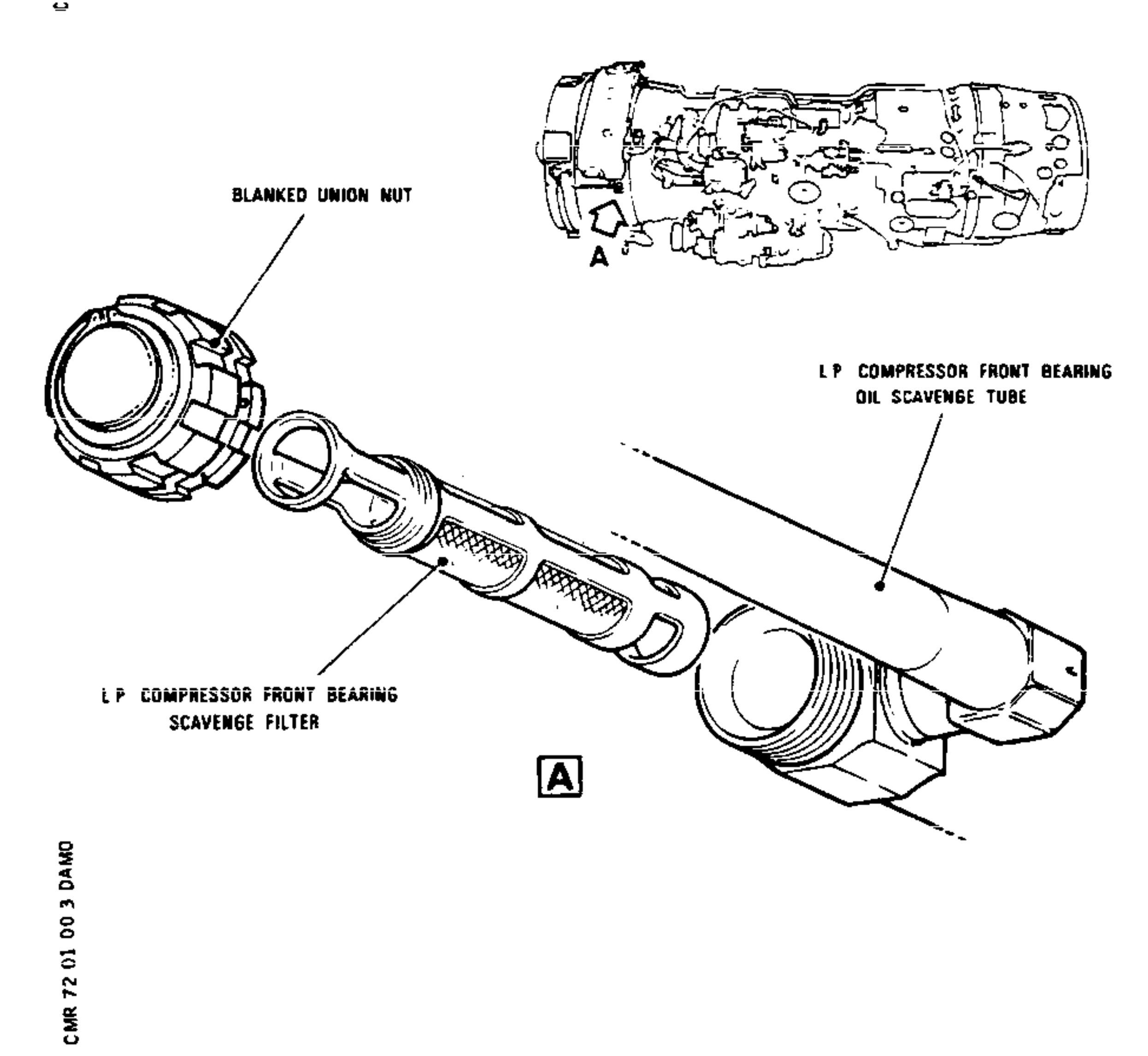
B. Tools and Equipment

C torque spanner for filter blanked union nut	T3.AA.2456
Adapter for oil filter retaining rings	PE.21162
Drift, quick attach/detach nut assembly	PE.3778
Filter papers	18 in diameter P300-125 micron
Funnel	Local manufacture to suit filter paper and container

C. Prepare to Remove Filters

(1) Open engine bay front lower door (Ref. 71-00-00, Servicing).

ICR 31221/00A



CMR 72 01 00 3 DAMO

LP Compressor Front Bearing Scavenge
Figure 304

D. LP Compressor Front Bearing Scavenge Filter (Ref. Fig. 304)

(1) Remove Filter

(a) Clean union nut and surrounding area of filter location.

(b) Position container under filter location to catch oil drainage.

(c) Fold filter paper to form a cone of similar angle to that of funnel, insert filter paper into funnel and assemble funnel to container. Mark filter paper with engine number and filter position.

(d) Remove union nut from filter location and place in the filter paper.

(e) Withdraw filter unit and allow oil to drain into container.

(f) Visually examine the internal surface of the filter and assess the degree of contamination. Place filter in filter paper.

(g) Carry out filter inspection, process filter paper and measure and record the quantity of oil drained as detailed in 72-01-00, Inspection/Check.

(2) Install Filter

(a) Insert filter unit into its location, element end inward.

(b) Ensure that blanking ferrule and circlip are correctly assembled to union nut and apply lubricant A (Ref. 70-00-01, Servicing and Storage Materials). Assemble blanked union nut to filter housing.

(c) Restrain filter housing against turning and torque-tighten nut to 500 lbf in (56 Nm).

(d) Wire-lock nut to oil tube elbow.

(e) With the oil tank full (Ref. 12-13-79) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to the amount drained during the removal procedure.

(f) On completion of work, close engine bay door (Ref.71-00-00, Servicing).

E. LP and HP Compressor Thrust Bearings and LH Gearbox Scavenge Filter, LP Turbine Bearing Scavenge Filter and HP Turbine Bearing Scavenge Filter (Ref. Fig. 305).

NOTE: Procedure given applies to each of the above filters and to pre S.B. and S.B. standards of S.B.OL. 593-72-27.
and Location Detail

(1) Remove filter.

(a) Drain oil from left-hand gearbox as detailed in paragraph 2.D.

(b) Clean valve body unit and surrounding area of filter location.

(c) Position container under filter location to catch oil drainage.

(d) Fold filter paper to form a cone of similar angle to that of funnel, insert filter paper into funnel and assemble funnel to container. Mark filter paper with engine number and filter position.

(e) Unscrew and remove retaining ring then withdraw valve body unit and filter assembly. Allow oil to drain into container.

(f) Withdraw inner filter unit from outer filter unit and detach spring. Unscrew valve body unit from outer filter unit, retain both filter units for examination and then place all other items in the filter paper.

(g) Visually examine the internal surface of the outer filter unit and the external surface of the inner filter unit and assess the degree of contamination. Place both the filter units in the filter paper.

(h) Carry out filter inspection, process filter paper and measure and record quantity of oil drained as detailed in 72-01-00, Inspection/Check.

(2) Install filter.

CR 31222/00E
BS00000028/5

A

FORWARD

HP TURBINE BEARING SCAVENGE FILTER LOCATION

MAIN OIL PUMP

LP AND HP THRUST BEARINGS AND LH GEARBOX SCAVENGE FILTER LOCATION

SPRING

INNER FILTER UNIT

OUTER FILTER UNIT

VALVE BODY UNIT

OUTER FILTER UNIT

LOWER SUPPORT RING

LUGS

LP TURBINE BEARING SCAVENGE FILTER

VALVE BODY UNIT

MAGNETIC PLUG

RETAINING RING

FILTER ASSEMBLY (S B 72-8448-226)

FILTER ASSEMBLY (PRE S B 72-8448-226)

Main Oil Pump Scavenge Filters
Figure 305

CAUTION: ENSURE THAT FILTER UNIT IS FULLY ASSEMBLED TO VALVE BODY UNIT.

(a) Screw outer filter unit onto valve body unit until all its thread has entered the undercut provided.

(b) Assemble spring to inner filter unit ensuring that it is fully engaged.

(c) Assemble inner filter unit to outer filter unit (Ref.Fig.305).

(c1) On engines to S.B. OL.593-72-8448-226 standard, assemble inner filter unit centrally into outer filter unit.

(c2) On engines to pre S.B. OL.593-72-8448-226 standard, assemble inner filter unit centrally into outer filter unit and locate the lower support ring of inner filter unit inside the three lugs of the outer filter unit.

(d) Apply lubricant A to retaining ring.

(e) Install filter assembly in its location and secure in position with retaining ring torque-tightened to between 60 and 70 lbf ft. (81,5 and 96 Nm).

B CAUTION: TAKE CARE TO ENSURE THAT RETAINING RING IS
B NOT OVERTIGHTENED. FAILURE TO DO SO MAY
B RESULT IN FILTER HOUSING INSERT LOCATION
B PINS SHEARING.

(f) Wire-lock retaining ring to pump casing and valve body unit to retaining ring.

(g) With the oil tank full (Ref.12-13-79) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to the amount drained during the removal procedures.

(h) On completion of work, close engine bay door (Ref.71-00-00, Servicing).

F. Right-hand Gearbox Scavenge Filter (Ref. Fig.306 or 306A).

R CAUTION: ON PARTS TO SB OL.593-72-9036-419 STANDARD, IT
R MAY BE NECESSARY (DUE TO THE POSSIBLE ADHERENCE
R OF THE "O" RING TO THE JOURNAL) TO USE
R CONVENTIONAL HAND TOOLS TO AID THE REMOVAL OF THE
R MCD BODY ASSEMBLY, AS PART OF THE FILTER
R REMOVAL SEQUENCE. DURING THIS OPERATION IS IS
R ESSENTIAL THAT EXTREME CARE IS TAKEN, SO AS TO
R NOT DAMAGE ANY PART OF THE ASSEMBLY.

(1) Remove filter.

(a) Clean area of filter location.

(b) Drain oil from right-hand gearbox as detailed in paragraph 2.E.

CR 31223/00C

FORWARD

RIGHT HAND GEARBOX

QUICK ATTACH/DETACH ADAPTER

A

METAFLEX SEAL

METAFLEX SEAL

SCAVENGE FILTER UNIT

PRESSURE FILTER UNIT

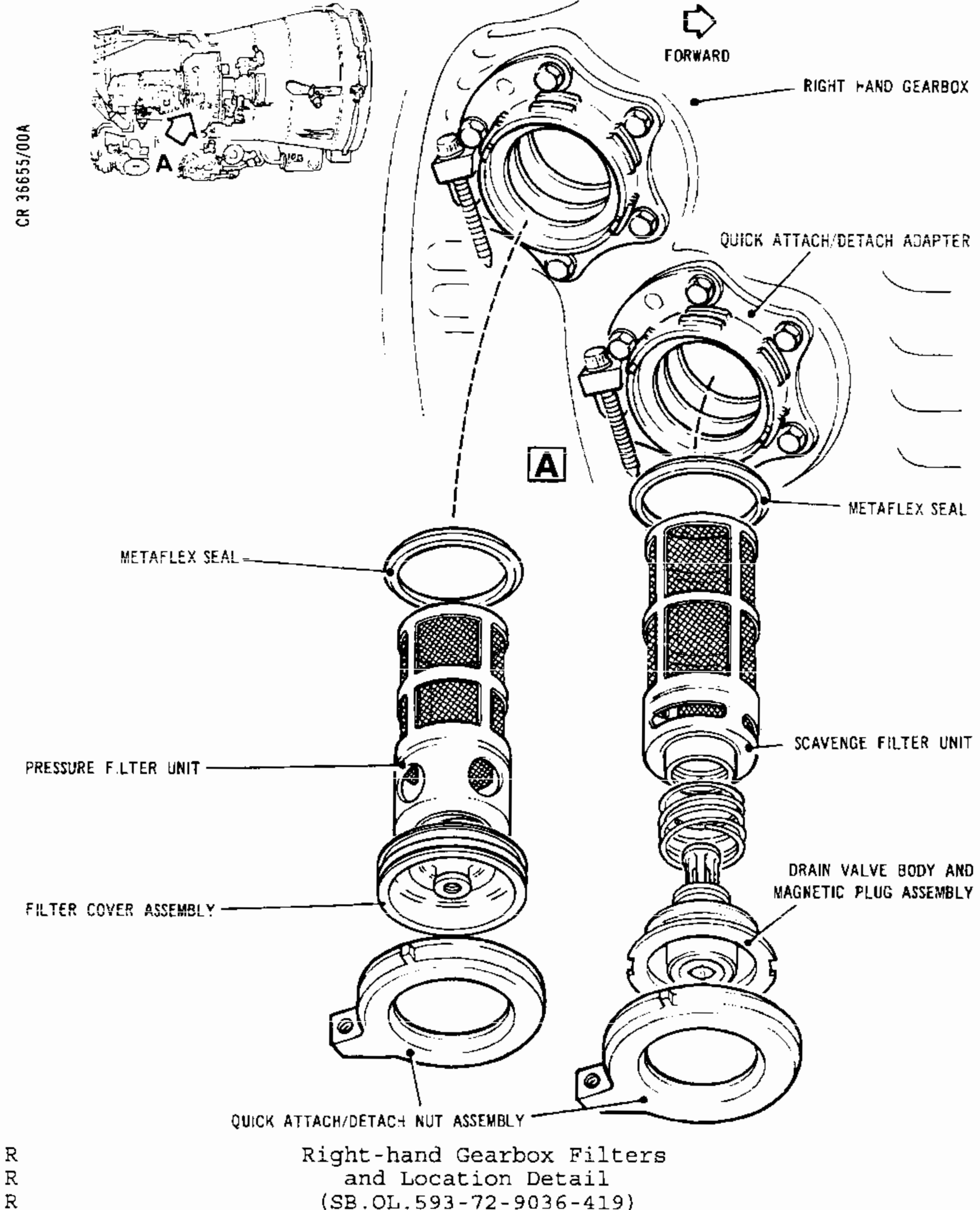
DRAIN VALVE BODY AND MAGNETIC PLUG ASSEMBLY

FILTER COVER ASSEMBLY

QUICK ATTACH/DETACH NUT ASSEMBLY

CMR 72 01 00 3 FAMO

Right-hand Gearbox Filters
and Location Detail
(Pre SB.OL.593-72-9036-419)
Figure 306



R Right-hand Gearbox Filters
R and Location Detail
R (SB.OL.593-72-9036-419)
R Figure 306A

(c) Fold filter paper to form a cone of similar angle to that of funnel, insert filter paper into funnel and assemble funnel to container. Mark filter paper with engine number and filter position.

(d) Position container under filter location to receive filter items and residual oil drainage.

(e) Release drain valve and magnetic plug assembly quick attach/detach nut assembly.

(e1) Unscrew and remove bolt and spherical washer from locking trunnion.

(e2) Use the approved drift against flat face of lug and drive nut assembly in direction to separate locking trunnions until loosened.

(e3) Turn nut assembly until threads disengage and align with their withdrawal slots. Remove nut assembly.

(f) Withdraw drain valve and magnetic plug assembly, filter unit and sealing ring, squarely from gearbox. Allow oil to drain into container.

(g) Separate filter unit, spring and drain valve and magnetic plug assembly by unscrewing filter from valve body, retain filter for examination and place all other items in the filter paper.

(h) Visually examine the internal surface of the filter and assess the degree of contamination, then place the filter in the filter paper.

(j) Carry out filter inspection, process filter paper and measure and record quantity of oil drained as detailed in 72-01-00, Inspection/Check.

(2) Install Filter.

(a) Ensure that quick attach/detach nut assembly components are serviceable.

<u>CAUTION</u>: ENSURE THAT FILTER UNIT IS FULLY ASSEMBLED TO DRAIN VALVE AND

MAGNETIC PLUG ASSEMBLY.

(b) Assemble filter unit to drain valve body.

(b1) Position spring on drain valve body.

(b2) Screw filter unit onto drain valve until all its thread has entered the undercut provided.

(b3) Check spring action.

(c) Apply lubricant A (Ref.70-00-01, Servicing and Storage Materials) to quick attach/detach nut assembly threads and abutment flanges, and to clamping bolt, spherical nut and washer.

CAUTION: ENSURE THAT SEAL AND ADAPTER ARE TO SAME SERVICE BULLETIN STANDARD.

(d) Ascertain whether the gearbox mounted QAD adapter is to pre S.B.OL.593-72-7 or S.B.72-7 standard and assemble a serviceable Metaflex seal (Ref. 70-00-03, Sealing Devices) of the same standard to the adapter groove.

NOTE: Metaflex seals to S.B.OL.593-72-7 standard incorporate one and a half loose turns of stainless steel wrapper positioned around the outer circumference. This area is not laminated with asbestos and is not spot welded. Seals of this type must not be mistakenly rejected for spot weld failure in this area.

(e) Enter filter with drain valve and magnetic plug assembly into quick attach/detach adapter on gearbox ensuring that slots in drain valve flange engage lugs on adapter.

(f) Hold drain valve flange hard against seal through base of quick attach/detach nut assembly and engage threads of nut assembly with those of threaded flange as far as possibly by hand.

CAUTION: ENSURE THAT THREADS HAVE ENGAGED FREELY BEFORE APPLYING TIGHTENING FORCE TO NUT ASSEMBLY.

(g) Position spherical washer on clamping bolt then insert bolt through fixed locking trunnion to engage spherical nut of nut assembly trunnion by hand. Screw in clamping bolt and check that the locking (run-down) torque is within limits 3 to 10 lbf in. (0,3 to 1,1 N.m).

(h) Tighten and lock nut assembly.

(h1) Ensure that nut assembly is hand-tight.

(h2) Torque-tighten clamping bolt to 60 lbf in. (6,8 N.m).

(j) Finally tighten clamping bolt.

(j1) Slacken bolt and ensure that locking (run-down) torque is still within limits 3 to 10 lbf in. (0,3 and 1,1 N.m).

(j2) Torque-tighten bolt to 60 lbf in. (6,8 N.m).

(k) With oil tank full (Ref.12-13-79) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to the amount drained during the removal procedures.

(l) On completion of work, close engine bay door (Ref.71-00-00, Servicing).

R G. Right-hand Gearbox Pressure Filter (Ref. Fig.306 or 306A).

(1) Remove filter.

(a) Clean area of filter location.

(b) Fold filter paper to form a cone of similar angle to that of funnel, insert filter paper into funnel and assemble funnel to container. Mark filter paper with engine number and filter position.

(c) Position container under filter location to catch oil drainage.

(d) Release filter cover assembly quick attach/detach nut assembly.

(d1) Unscrew and remove bolt and spherical washer from locking trunnion.

(d2) Use the approved drift against flat face of lug and drive nut assembly in direction to separate locking trunnions until loosened.

(d3) Turn nut assembly until threads disengage and align with their withdrawal slots. Remove nut assembly.

(e) Withdraw filter cover assembly, filter unit and sealing ring squarely from gearbox. Allow oil to drain into container.

(f) Separate filter unit spring and cover assembly by unscrewing filter from cover, retain filter for examination and place all other items in the filter paper.

(g) Visually examine the internal surface of the filter and assess the degree of contamination, then place the filter in the filter paper.

(h) Carry out filter inspection, process filter paper and measure and record quantity of oil drained as detailed in 72-01-00, Inspection/ Check.

(2) Install filter.

(a) Ensure that quick attach/detach nut assembly components are serviceable.

CAUTION: ENSURE THAT FILTER UNIT IS FULLY ASSEMBLED TO FILTER COVER ASSEMBLY.

(b) Assemble filter unit to filter cover assembly.

(b1) Position spring on cover.

(b2) Screw filter unit onto cover until all its thread has entered the undercut provided.

(b3) Check spring action.

(c) Apply lubricant A to quick attach/detach nut

assembly threads and abutement flanges, and to clamping bolt, spherical nut and washer.

CAUTION: ENSURE THAT SEAL AND ADAPTER ARE TO SAME SERVICE BULLETIN STANDARD.

(d) Ascertain whether the gearbox mounted QAD adapter is to pre S.B.OL.593-72-7 or S.B.72-7 standard and assemble a serviceable Metaflex seal (Ref. 70-00-03, Sealing Devices) of the same standard to the adapter groove.

NOTE: Metaflex seals to S.B.OL.593-72-7 standard incorporate one and a half loose turns of stainless steel wrapper positioned around the outer circumference. This area is not laminated with asbestos and is not spot welded. Seals of this type must not be mistakenly rejected for spot weld failure in this area.

(e) Enter filter and filter cover assembly into quick attach/detach adapter on gearbox ensuring that slots in filter cover assembly engage lugs on adapter.

(f) Hold filter cover assembly hard against seal through base of quick attach/ detach nut assembly and engage threads of nut assembly with those of threaded flange as far as possible by hand.

CAUTION: ENSURE THAT THREADS HAVE ENGAGED FREELY BEFORE APPLYING TIGHTENING FORCE TO NUT ASSEMBLY.

(g) Position spherical washer on clamping bolt then insert bolt through fixed locking trunnion to engage spherical nut of nut assembly trunnion by hand. Screw in clamping bolt and check that the locking (run-down) torque is within limits 3 to 10 lbf in (0.3 and 1,1 N.m).

(h) Tighten and lock nut assembly.

(h1) Ensure that nut assembly is hand-tight.

(h2) Torque-tighten clamping bolt to 60 lbf.in (6,8 N.m).

(j) Finally tighten clamping bolt.

(j1) Slacken bolt and ensure that locking (run-down) torque is still within limits 3 to 10 lbf in. (0,3 and 1,1 N.m).

(j2) Torque-tighten bolt to 60 lbf in (6,8 N.m).

(k) With the oil tank full (Ref.12-13-79) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to the amount drained during the removal procedure.

(l) Close engine bay door (Ref.71-00-00, Servicing).

H. Main Oil Pump Delivery Pressure Filter (Ref. Fig.307 or
R 307A).

(1) Prepare to remove filter.

(a) Clean area of filter location.

(b) Fold filter paper to form a cone of similar angle to that of funnel, insert filter paper into funnel and assemble funnel to container. Mark filter paper with engine number and filter position.

(c) Position container under filter location to catch oil drainage.

(2) Remove filter to pre S.B.OL.593-72-49 standard.

<u>NOTE:</u> Procedure given applies to both pre S.B. and S.B. standards of S.B.OL.593-72-112.

(a) Verify the procedure detailed in paragraph (1) is completed.

(b) Unscrew and remove retaining ring. Withdraw filter assembly squarely from oil pump and allow oil to drain into container.

R (c) Unscrew and remove strainer from cover, retain strainer for examination and place the cover in the filter paper.

(d) Visually examine the internal surface of the strainer and assess the degree of contamination and then place the strainer in the filter paper.

CR 31224/00B

MAIN OIL PUMP

A

STRAINER

PRE SB. 72-49

SB. 72-49

SPRING

OUTER ELEMENT

INNER ELEMENT

COVER

PRE SB. 72-27

RETAINING RING

SB. 72-27

RETAINER

CMR 72 01 00 3 CAMO

Main Oil Pump Delivery Pressure Filter
R (Pre SB.OL.593-72-9036-419)
Figure 307

CR 36650/00A

A

MAIN OIL PUMP

A

SPRING

OUTER
ELEMENT

INNER
ELEMENT

RETAINER

R Main Oil Pump Delivery Pressure Filter
R (SB.OL.593-72-9036-419)
R Figure 307A

(e) Carry out filter inspection, process filter paper and measure and record quantity of oil drained as detailed in 72-01-00, Inspection/Check.

(3) Remove filter to S.B.OL.593-72-49 standard.

R NOTE: This procedure also applies to the filters with
R retainers to SB.OL.593-72-9036-419
R (Ref. Fig.307A).

(a) Verify the procedure detailed in paragraph (1) is completed.

(b) Unscrew and remove retaining ring. Withdraw filter assembly squarely from oil pump and allow oil to drain into container.

(c) Unscrew and remove retainer from outer filter element and place retainer in filter paper cone.

(d) Remove bolt, washer and nut securing spring and
R inner and outer filter elements together. Retain both filter elements for examination and place all other items in the filter paper.

(e) Visually examine the internal surface of the outer element and the external surface of the inner element and assess the degree of contamination. Place both the filter elements in the filter paper.

(f) Carry out filter inspection, process filter paper and measure and record quantity of oil drained as detailed in 72-01-00, Inspection/Check.

(4) Install filter to pre S.B.OL.593-72-49 standard.

CAUTION: ENSURE THAT COVER/DRAIN PLUG ASSEMBLY AND STRAINER ASSEMBLY ARE TO SAME SERVICE BULLETIN STANDARD AND THAT COVER IS FULLY ASSEMBLED TO STRAINER.

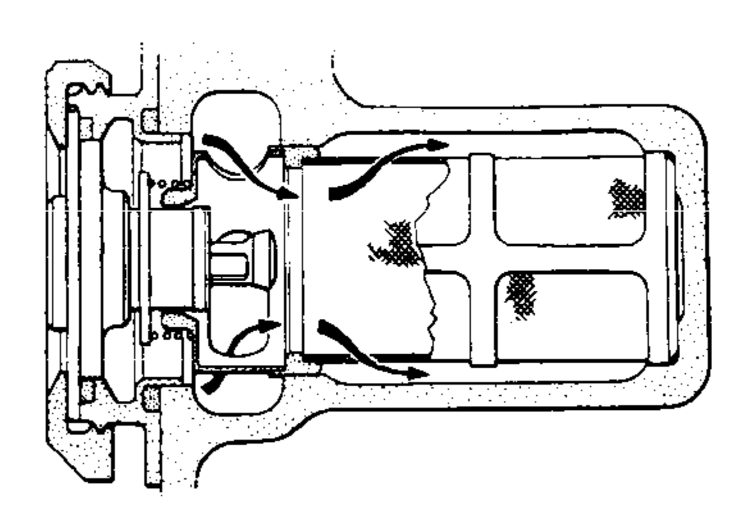
NOTE: The procedure applies to pre S.B. and S.B. standard of both S.B.OL.593-72-27 and 72-112.

(a) Screw cover onto strainer until all the thread of strainer enters undercut provided in cover.

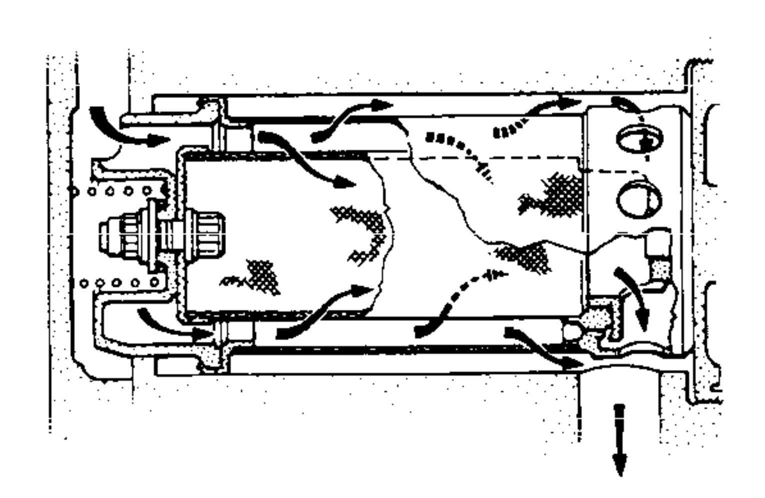
(b) Apply lubricant A to retaining ring.

(c) Locate filter assembly in its location and secure with retaining ring torque-tightened to between

CR 34799/00A



TYPICAL OIL FLOW THROUGH SINGLE ELEMENT FILTER



TYPICAL OIL FLOW THROUGH DOUBLE ELEMENT FILTER

CMR 72 01 00 3 HAMO

Typical Oil Flow through Single and
Double Element Filters
Figure 308

125 and 135 lbf ft. (170 and 183 N.m).

(d) Complete the installation as detailed in paragraph (6).

(5) Install filter to S.B.OL.593-72-49 standard.

<u>CAUTION:</u> ENSURE RETAINER/DRAIN PLUG ASSEMBLY AND FILTER ELEMENTS ARE TO THE SAME SERVICE BULLETIN STANDARD.

R <u>NOTE 1:</u> Procedure given applies to pre S.B. and S.B.
standards of S.B.OL.593-72-27.

R <u>NOTE 2:</u> This procedure also applies to the filters
R with retainers to SB.OL.593-72-9036-419
R Ref.Fig.307A).

R (a) Assemble filter for installation (Ref. Fig.307 or
R 307A).

(a1) Assemble inner element to outer element.

(a2) Insert bolt from inside.

(a3) Assemble spring to bolt protrusion with small coil abutting outer element end and place washer in position over bolt to retain spring.

(a4) With lubricant A applied, secure assembly with nut torque-tightened to bolt to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(b) Screw retainer into outer filter element until all threads of the retainer enter the element.

(c) Apply lubricant A to retaining ring.

(d) Locate filter assembly in its location and secure with retaining ring torque-tightened to between 125 and 135 lbf ft. (170 and 183 N.m).

(e) Complete the installation as detailed in paragraph (6).

(6) Complete the installation.

(a) Ensure screwed plug and serviceable seal (Ref.70-00-03, Sealing Devices), of the correct Service Bulletin Standard, are installed and that plug is torque-tightened to between 230 and 250 lbf in. (26 and 28 N.m) with lubricant A applied.

(b) Wire-lock retaining ring to pump casing and screwed plug to retaining ring.

(c) With the oil tank full (Ref.12-13-79) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to the amount drained during the removal procedure.

(d) On completion of work, close engine bay door (Ref.71-00-00, Servicing).

ENGINE LUBRICATION SYSTEM - ADJUSTMENT/TEST

1. General

The system operating pressure is controlled by an adjustable relief valve housed in the base of the main oil pump in the left hand gearbox. Adjustment must only be made when the engine is stationary.

CAUTION: A DRY CYCLE CHECK OR IDLE LEAK CHECK MAY NOT CONFIRM THAT A JOINT IS LEAK FREE.

Following disturbance to the oil tubes, it is necessary to carry out a ground run (Ref. 71-00-00, Adjustment/Test) and check for oil leakage.

2. Adjust the Main Oil Pump Relief Valve (Ref. Fig. 501)

A. Prepare to Adjust the Relief Valve

RB CAUTION: THE THEORETICAL ADJUSTMENT OF OIL PRESSURE
RB APPROXIMATES 1 PSI TO A 1/4 TURN OF THE ADJUSTER.
RB WHEN AN ADJUSTMENT HAS BEEN MADE AND THE CHANGE
RB IN PRESSURE EXHIBITS A WIDE MARGIN OF ERROR, THE
RB VALVE ADJUSTER MUST BE STRIPPED AND INSPECTED TO
RB ENSURE SERVICEABILITY.

(1) Before adjustment, the pressure setting should be checked as detailed in 71-00-00, Adjustment/Test.

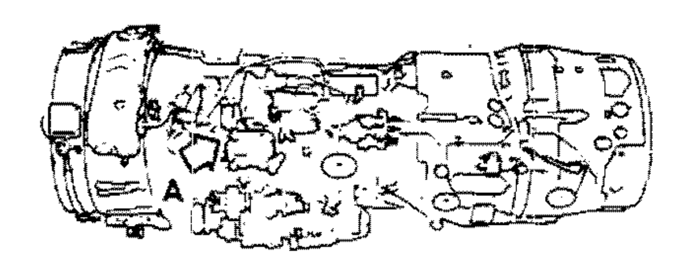
(2) On engines to pre SB.OL593-72-8562-146 standard, continue with the procedure given in paragraph B.

(3) On engines to SB.OL.593-72-8562-146 standard (restricted oil feed tube), the engine must be returned to the pre SB standard before adjustment and setting checks are carried out.

(a) Remove the restrictor and reconnect the oil tube. On No.1 and No.3 engines, it is necessary to remove the engine (Ref. 71-00-12) to return the engine to the pre service bulletin standard.

(b) With engines installed, adjust the oil pressure as detailed in paragraph B., until pressure is within the acceptance limits given for the pre SB.72-146 standard (Ref. 71-00-00, Adjustment/Test).

CR 31647/00A



RELIEF VALVE HOUSING

MAIN OIL PUMP

A

SEAL

CAPNUT

ADJUSTER

LOCKNUT

CMR 72 01 00 5 AAMO

Adjustment of the Main Oil Pump Relief Valve
Figure 501

(c) Install the restrictor and return the engine to the SB72-146 standard. It will be necessary to remove No.1 and No.3 engines for this purpose.

CAUTION: DO NOT ADJUST PRESSURE WITH RESTRICTOR INSTALLED.

(d) With engines installed, carry out a check of the oil pressure (Ref. 71-00-00, Adjustment/Test). Pressure must be within the limits stated for the SB.72-146 standard to be acceptable.

(e) After pressure adjustment, do engine high power ground runs and accelerations to establish the effective change the adjustment has made. A wide margin of error between theoretical value of the adjustment and the actual result obtained, requires the aircraft to be subjected to further investigation before release for flight.

(f) Following satisfactory pressure adjustment, the following requirements must be clearly stated in the relevant aircraft documentation.

- An additional 2 quarts of oil are to be uplifted on the next six sectors until the consumption trend is firmly established.
- Flight crew must be alerted to the pressure adjustment for the next two sectors. They must confirm and record the oil pressure reading.
- Flight crew must be advised that if during low N2 settings i.e. top of descent, it is possible (if the adjustment was incorrect) that a low oil pressure warning may result. If this occurs and oil quantity is normal for this point in flight, oil pressure may be re established by increasing N2. This will avoid the need for a precautionary inflight shut down.

B. Adjustment Procedure

(1) Remove the capnut.

(2) Loosen the locknut a few turns.

(3) Adjust the relief valve setting by screwing the adjuster, with a broad bladed screwdriver,

clockwise to increase the pressure and counter-clockwise to decrease the pressure.

One quarter turn = approximately 1 psi.

(4) Torque-tighten locknut to between 170 and 190 lbf in (19.2 and 21.5 Nm).

(5) Ensure seal is positioned in the recess in the capnut, assemble capnut to relief valve and torque-tighten to between 170 and 190 lbf in (19.2 and 21.5 Nm).

(6) Wire-lock capnut to the lug on the oil pump casing.

(7) Close the engine bay front lower door (Ref. 71-00-00, Servicing).

ENGINE LUBRICATION SYSTEM - INSPECTION/CHECK

1. General

Magnetic plugs can give an early indication of possible engine failure but experience is required to accurately interpret the origin and amounts of metal deposits that can be found on the plug probes. Some engines tend to accumulate more deposits than others and those with low running hours may deposit turned metal particles or shavings which are not symptoms of engine failure. In order to accurately assess these metal deposits it is essential that the metal retained by the magnetic plugs is removed and, if necessary, subjected to laboratory examination as well as being referenced to the engine number and hours run. It should then be retained in the respective engine records for further reference.

Scheduled magnetic plug inspections would normally be done whilst the aircraft is local to the main base which would permit the operation to be performed by an experienced engineer with access to the engine records for reference purposes.

Occasions may arise, particularly when trouble shooting, when an unscheduled inspection of the magnetic plugs may be required away from base and be carried out by an engineer with limited experience in assessing the implications of the information presented to him. Reference to the engine records is essential in this instance in order to make a quantitative assessment, particularly when a borderline case occurs.

Magnetic plugs may be processed at scheduled inspections by either transferring deposits from the plug probe to adhesive transparent tape as detailed in paragraph 2.B. or by returning the magnetic plug with the deposits undisturbed to the Engine Health Monitoring Centre for examination (Ref.para.2.C.). Clean replacement plugs are installed when the latter procedure is used. When an unscheduled inspection is required, conform to the procedure detailed in paragraph 3.

CAUTION: A DRY CYCLE OR IDLE LEAK CHECK MAY NOT CONFIRM THAT A JOINT IS LEAK FREE.

Following disturbance to the filters, drain plugs, MCD's or hydraulic piper connections, it is necessary to do a ground run (Ref.71-00-00, Adjustment/Test) and check for oil leakage.

R The appendix which follows this procedure gives details of
R the different material which can be found within oil-washed
R compartments in the engine. It is included primarily to
R assist in identifying the source of engine oil system
R contamination.

2. Magnetic Plugs - Scheduled Servicing

A. General.

(1) When magnetic plugs are removed for inspection, assess the deposit on the probe. If the deposit appears above normal, then the engine should not be cleared for flight until a check of the deposits proves satisfactory.

B. Process Plug Probe Deposits Using Adhesive Tape.

(1) Take a magnetic plug from the container and remove the protective sleeve from the probe taking care not to disturb any of the adhering debris.

(2) Carefully wash the magnetic plug in white spirit to remove oil, again ensuring that no debris is knocked off the probe. Lay plug on paper towel to dry off.

(3) Roll the probe along a strip of transparent adhesive tape to collect all the debris particles adhering to it. Any debris which may have become transferred to the protective sleeve is to be carefully removed and added to that on the adhesive tape.

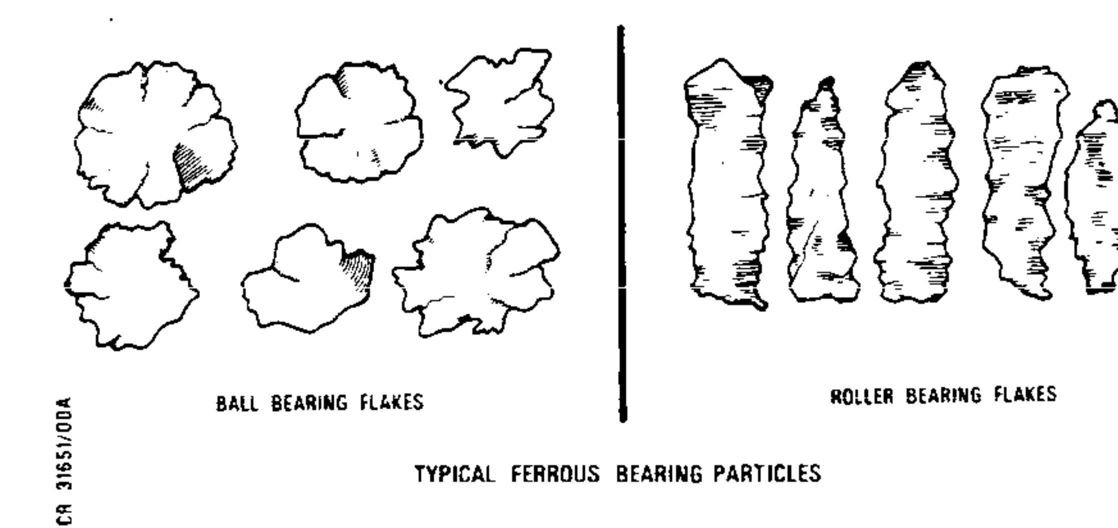
(4) Attach the strip of adhesive tape containing the debris to the relevant column of the appropriate engine record card, ensuring that the debris is trapped between the tape and card. Record the engine running time and date of entry.

(5) Send any debris of a suspicious nature that is found for a detailed microscopic examination.

NOTE: On the first examination of magnetic plugs from a new engine a certain amount of "build" debris may be encountered and this must be taken into account.

(6) The following description of the more significant ferrous particles which could be found in deposits on the probes is given to assist accurate identification. Figure 601 shows typical examples of these particles.

(a) Roller bearing flakes are of irregular shape, of a length two or three times greater than width and with crinkles across their width.



TYPICAL FERROUS BEARING PARTICLES

A/C	NACELLE
ENGINE Nº	
FILTER	
RUNNING TIME HOURS	MINS.
DATE	
SIGNATURE	

FILTER INSPECTION RECORD ENVELOPE

CMR 72 01 00 6 AAMO

Bearing Particle Identification and Typical Debris Record
Figure 601

(b) Ball bearing flakes are shiny, hard flat flakes, with cross-cross scratches. They are rounder and more uniform than roller bearing flakes.

(7) Evaluate deposits and comply with the inspection procedures where necessary.

(a) Small deposits of minute steel particles (which form a fur or dust around the magnet) or dull hair-like slivers of steel are normal and are generally acceptable. The rate of accumulation of this type of deposits will vary from engine to engine but should not increase with engine life unless increasing wear of windback seals, accompanied by an increasing oil consumption rate, is occuring. In this instance, the engine rejection could be dependant on the oil consumption rate.

(b) If steel flakes or slivers of irregular pattern are found, laboratory examination should be carried out to determine their origin. If the flakes and slivers are hard and bright, it could be indicative of a bearing failure. The following action should be taken:

(i) If not already removed, remove and examine the right-hand gearbox magnetic plug.

(ii) Remove and examine the Air Turbine Starter magnetic plug (80-11-11).

(iii) Remove and examine the scavenge filters of the five, compressor, thrust and turbine, bearings. Evidence of further flakes or slivers in any one of these filters will be indicative of the module which is originating the failure.

(iv) Remove and examine the main and right-hand gearbox pressure filter.

(v) Collect any metal deposit found in the filter checks as detailed in paragraph 4.

(c) The total deposits must then be examined and referenced to previous records to determine which course of further action is necessary.

(d) Should the accumulated evidence indicate a gradual increase in the deposit rate i.e. above normal, a decision must then be made on the two possible courses:

(i) Replace all magnetic plugs, pressure and scavenge filters and, in addition replace the dummy plugs with magnetic plugs to the scavenge filter covers of LP and HP thrust bearings and HP and LP turbine bearings.

(ii) Either release the engine for further service with an increased magnetic plug inspection frequency (of all plugs) determined from the evidence available. or

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Ground run the engine over the speed range (including 30 seconds max. dry power) for not less than 5 minutes. Re-examine all the magnetic plugs and filters and from the new evidence either release the engine for further service or reject it.

(e) Should the accumulated evidence indicate a sharp increase in the deposit rate with an even greater deposit in the filters i.e. sufficient to warrant rejection, the debris should be examined in order to determine if there is any indication of the defective module. Should this not be apparent a decision must then be made to determine if the condition of the engine will allow a ground run, as detailed above, to be performed with the individual magnetic plugs fitted in order to indicate the defective module, or to reject the engine without this information.

(8) After a magnetic plug has been processed examine the probe visually and test for magnetism. A probe should be capable of lifting three unmagnetised steel 0.5 in. (13 mm) diameter balls. On completion, assemble a protective sleeve to the probe and place the magnetic plug in container. Return plugs for assembly in engine.

C. Process Plug Probe Deposits When Replacement Procedure is Used.

(1) The removed plugs can either be processed by visual methods prior to being labelled and retained in the Engine Health records for further reference, or by quantitative assessment using a debris tester or similar device.

(2) Assess deposits and comply with inspection procedure as detailed in paragraph B. (7).

3. <u>Magnetic Plugs Unscheduled Servicing</u>

A. Inspect Plug Probe.

(1) Remove plugs for examination but do not disturb deposits or transfer to adhesive transparent tape at this stage.

(2) Examine the deposits with a magnifying glass in order to detect whether there are any apparent steel flakes or slivers of irregular pattern in addition to the

minute steel particles and hair like slivers that are normal. This evidence must be weighed against information from the Technical Log of engine hours accumulated since the last scheduled inspection.

(3) Examine the deposit and assess if normal or above normal. As an indicator, the engine master magnetic plugs may be removed from the other three engines and compared with that of the suspect engine. The magnetic plugs must be installed in the "as remove" condition.

(4) If deposits are assessed as normal, install the plugs with the deposits undisturbed and in the same condition as when removed.

(5) If the deposits are above normal or should it not be possible to form an accurate judgment, proceed as follows:

(a) Remove and examine the scavenge filters from LP compressor front and thrust bearings, HP compressor thrust and turbine bearings and LP turbine bearing. Evidence of further flakes or silvers in any one of these filters will be indicative of the module which is originating the failure.

(b) Remove and examine the main and right-hand gearbox pressure filter.

(c) Collect any metal deposit found in the filter checks as detailed in paragraph 4.

4. Filters

A. General.

For details of servicing, removal/installation and inspection of the various filters, refer to paragraph 4 of 72-01-00 Servicing.

The conditions appertaining at the start of this procedure should be with the funnel in container, filter paper in funnel containing filter and deposits and oil drainage in container.

B. Tools and Equipment.

R Ultrasonic cleaner ... ... Spec. N/A

R Record envelopes ... ... Local supply

Filter paper (fine)	Sspec. N/A
Clean lint-free cloth...	Superstrong 917
Group 1 Solvent	Desoclean 45, Desoclean 20, Applied 8-300, Applied 8-000, Ardrox 5548, MS 38, MS 56, Lotoxane, Lotoxane Fast, Stoddards Solvent, Safranor, Turco 6646, Ardrox 161-K, Lemsolv
Engine oil	Lubricant A
Kerosine	Spec. N/A
White spirit	Spec. N/A
Compressor washing fluid	Z0K27, Castrol ICD177, Turbo clean, Ardrox 6345, Decon 72, Decon 90

C. Clean filter element using an appropriate ultrasonic cleaner. The cover may be cleaned using a clean lint free cloth and a group 1 solvent (70-00-01, Servicing and Storage Materials - Servicing).

(1) Using appropriate ultrasonic cleaner, clean filter element as follows:

(a) Cover both ends of filter element and kerosine wash thoroughly to remove all loose particles.

(b) Fill the ultrasonic cleaner, with hot tap water. Add 10 per cent of compressor washing fluid and operate cleaner for five minutes to ensure degasing of the tank fluid.

(c) Immerse filter element in a beaker containing a 20 per cent mixture of compressor washing fluid and boiling water. Place beaker in an ultrasonic cleaner filled with same mixture.

(d) Ultrasonically clean filter element for fifteen minutes operating ultrasonic cleaner at 50 KHz, pulsed at 2 times supply frequency.

(e) Remove filter element from ultrasonic cleaner and wash thoroughly in boiling water.

(f) Remove end covers and dry with a moisture free air blast.

(g) Ensure filter element is clean by holding it up to a strong light source and looking through filter element. If any blockage is still apparent repeat steps (c) to (f) ensuring both ends of filter are covered.

(h) Kerosine wash filter element to displace any remaining water particles and lightly oil filter element with clean engine oil.

(j) Strain residue of contaminated compressor washing fluid and boiling water mixture, from beaker, through fine filter paper. Retain any particles found in the filter element for examination.

D. Inspect Filter.

(1) Examine the filter for condition.

When inspecting a filter for possible metal and/or carbon contamination, the following procedure should be followed:

(a) Main Oil Pumps Delivery Pressure Filter (L/H Gearbox)

(a1) Pre SB72-49. Unscrew the cover plate from the base of the filter and examine the inner surface of the element.

(a2) Post SB72-49. Remove retainer, bolt, nut and washer separate the elements, and examine both inner surfaces.

(a3) The sudden blockage of the main oil pressure filter can be due to movement of carbon which has become detached from the oil washed areas by hygroscopic action (absorbs moisture). This can happen during prolonged storage of an engine prior to installation. Should a pressure filter be found to be blocked with carbon, carry out the following procedure:

a) Flush the oil system i/a/w chapter 79-00-04 page block 300 until all the carbon flakes have been removed.

b) Ground Run the engine at idle and then inspect the pressure filter. If carbon flakes are still present, the whole process should be repeated until all traces of carbon have been removed.

c) A further filter inspection should then be called up in 25 hours. Action in carried forward file.

(b) Main Oil Pump Scavenge Filters (L/H Gearbox)

(b1) Remove filter assemblies from valve body and withdraw inner filter from outer filter.

(b2) Examine the inner surfaces of both elements.

<u>NOTE:</u> On installation ensure the inner filter locates on the inside of the three lugs of the outer filter assembly.

(c) Pressure and Scavenge Filters (R/H Gearbox).

(c1) Remove filters and unscrew the respective filter cover assembly and drain valve body from the filter assembly.

(c2) Examine the inner surfaces of both elements.

(d) L.P. Compressor Front Bearing Scavenge (No.1 Bearing).

(d1) Remove filter from oil tube and inspect inner surface of filter element.

(2) If filter is damaged or in any way defective, obtain a serviceable filter.

(3) If filter is serviceable, re-install as detailed in 72-01-00, Servicing.

E. Process the Filter Paper.

(1) Spray a measured quantity of white spirit on the filter paper to dilute the oil and accelerate drainage and also to wash the deposits into the cone centre.

(2) Remove the filter paper carefully from the funnel and blot dry the underside of the paper with absorbent cloth, taking care to retain all deposits.

(3) Cut the central 2 in. dia. disc from the filter paper and place it together with its deposits in a record envelope.

(4) Record the relevant data (Ref.Fig.601) on the record slip and insert it in the envelope.

(5) Despatch the samples for processing.

F. Replenish Oil.

(1) With the oil tank full (Ref.12-13-79) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to that lost due to filter cleaning.

5. Oil Pipes

A. Various oil pipes in the Olympus 593 oil system rely on face-to-face flange sealing without the use of a gasket. Such installations are liable to leak during engine operation. If an oil leak develops is any one of the locations listed in Table 601 and a gasket is not fitted refer to the table and fit the appropriate gasket listed.

Gasket P/No.	Location of Pipe/Gasket	IPC Reference
B479677	Oil feed pipe - oil tank to oil pump in L/H gearbox - oil tank/pipe mating surface	79-22-01 Fig.1 Item 60A
B479666 or B477055	Oil feed pipe - oil tank to oil pump in L/H gearbox - face to face joint near anti-syphon pipe connection	79-22-01 Fig.1 Item 70B
B477565	Oil feed pipe - oil tank to oil pump in L/H gearbox - oil pipe/L/H gearbox mating surfaces	79-22-01 Fig.1 Item 120
B479672	Oil inlet temperature bulb located in oil feed pipe from oil tank to L/H gearbox. Bulb/pipe mating surface	79-32-01 Fig.1 Item 50A
B479675	Oil scavenge pipe - No.1 bearing to L/H gearbox - oil pipe/L/H gearbox mating surface	72-01-03 Fig.1 Item 310

Gasket P/No.	Location of Pipe/Gasket	IPC Reference
B484463	R/H gearbox - main and standby hydraulic pumps - seal drain pipe elbow/gearbox mating surface	72-63-01 Fig.7 Item 290A
B484462	Oil tank vent pipe - tank to over-board seal plate - joint before seal plate	75-02-02 Fig.1 Item 120
B484464	Oil drain pipe - hydraulic pump(s) adaptor(s) to overboard seal plate - tube/hydraulic pump adaptor mating surface	71-79-02 Fig.1 Item 80A

TABLE 601

B. Inspect No. 5 bearing oil feed and scavenge pipe barrelled location lands.

(1) Open engine bay rear door and gain access to the No. 5 bearing oil feed and scavenge pipes in the No. 5 & 6 vanes of the exhaust diffuser.

(2) Visually inspect the barrelled locating land of the tube end fittings for evidence of fret.

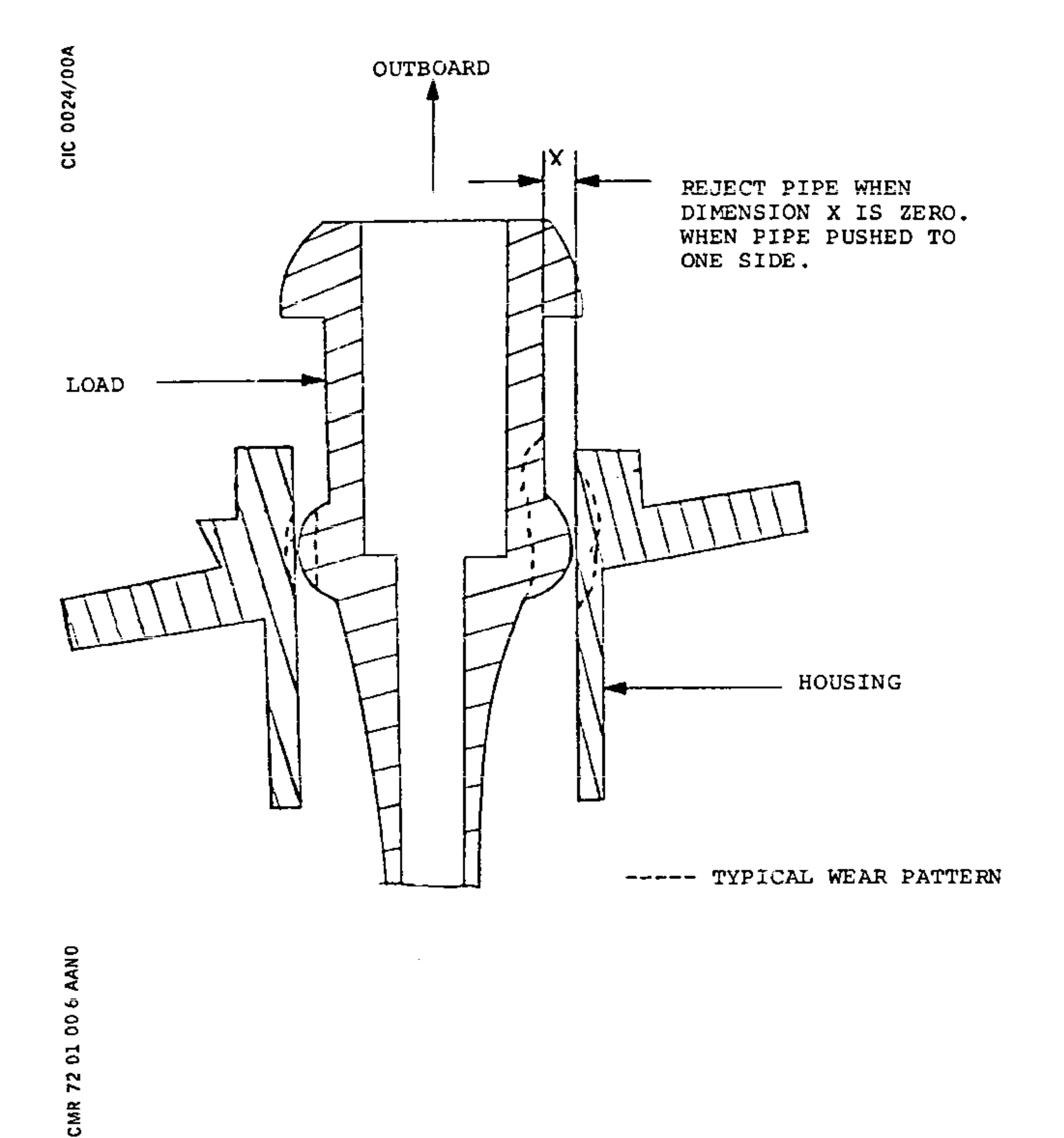
(3) A pipe and its housing is acceptable for service until the parallel portion of the pipe contacts the inner wall of the housing.

NOTE: The pipe must be pushed towards the housing inner wall in several different directions to check this. See (Ref. Fig. 602).

(4) Reject pipe when parallel portion of pipe contacts inner wall of housing. (Ref. Fig. 602).

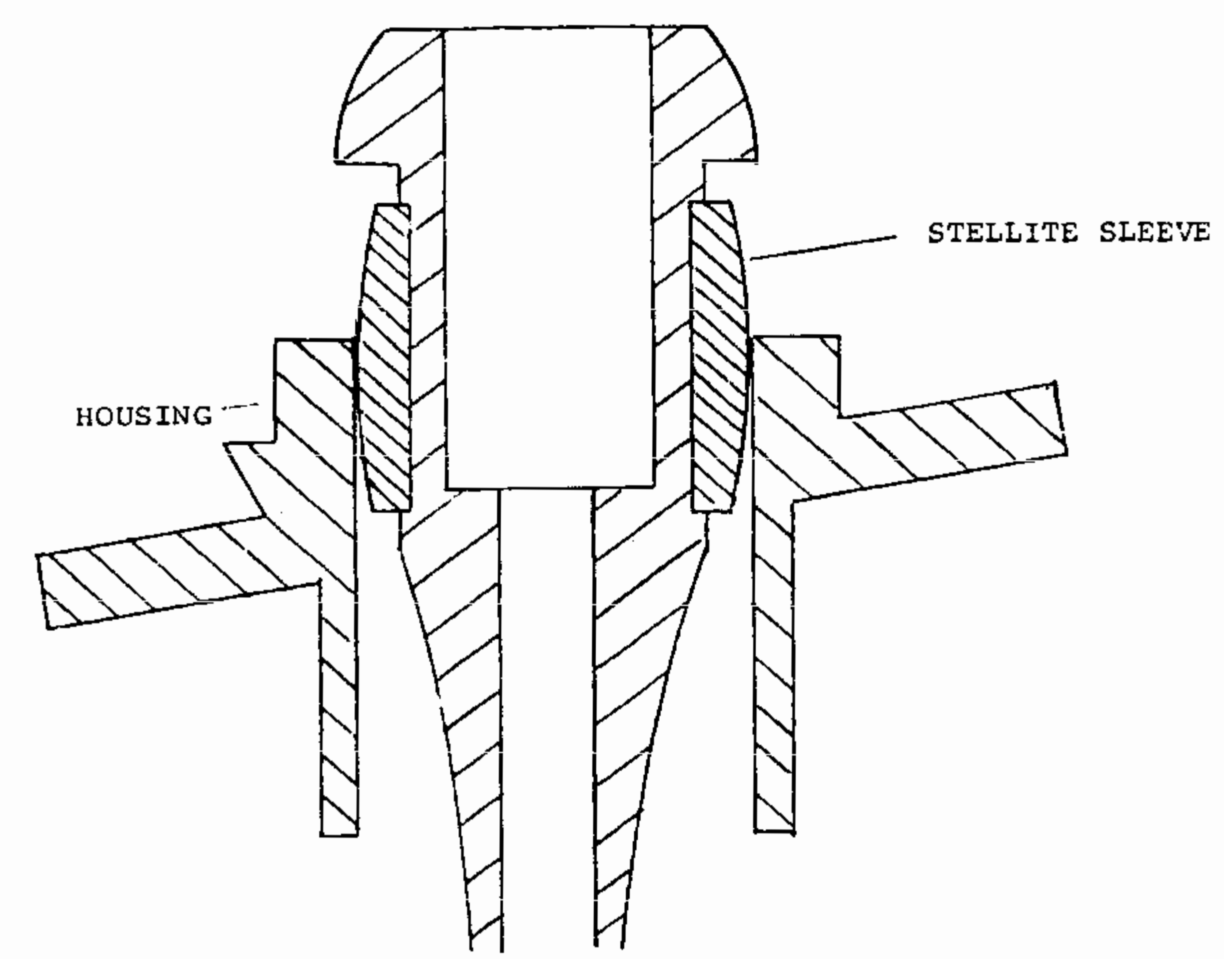
(5) Pre Mod. 45256

(a) On the modified pipes the narrow barrelled locating land has been replaced by a Stellite sleeve with the barrelling of much larger radius. (Ref. Fig. 604). In the new condition



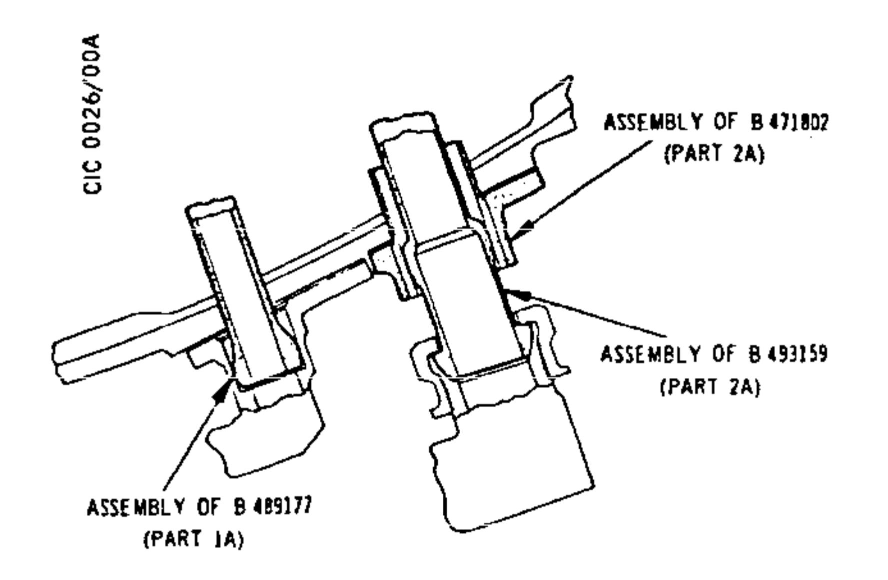
No. 5 Bearing Oil Pipe
Figure 602

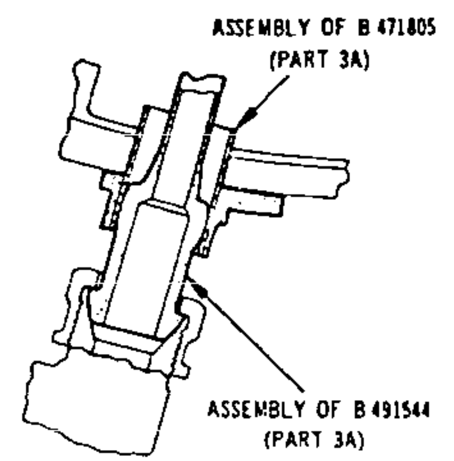
CIC 0025/00A



CMR 72 01 00 6 BANO

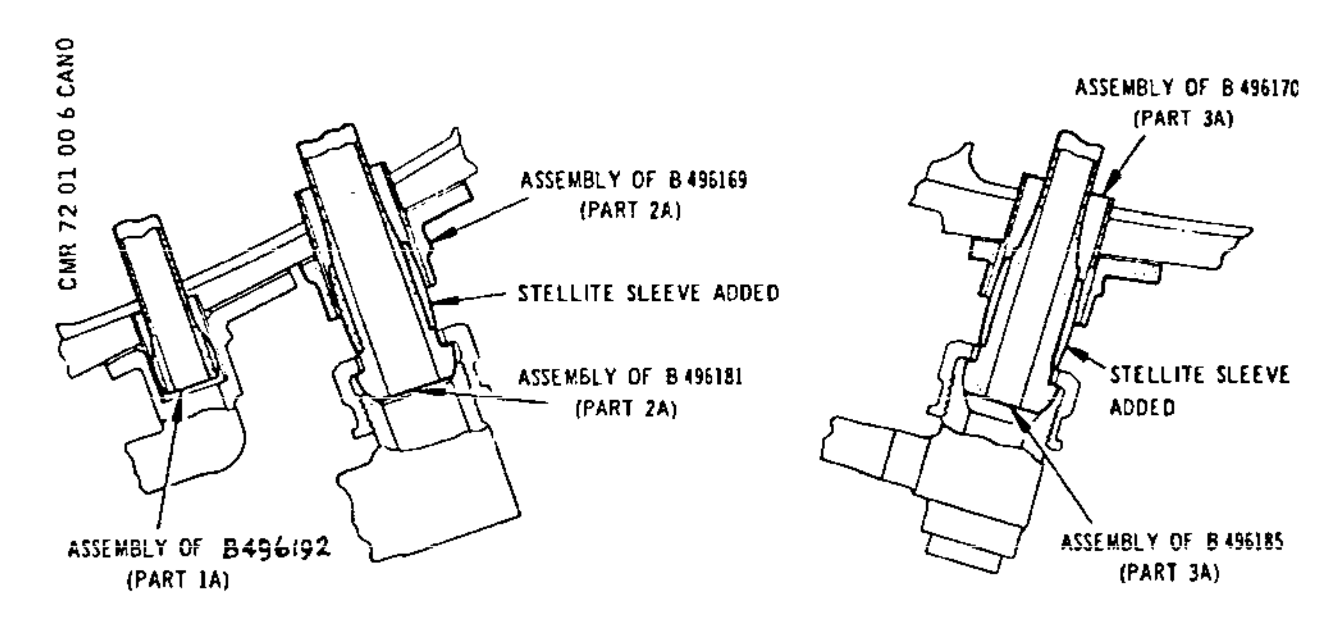
Mod CM45256 Pipe and Stellite Sleeve Filling
Housing Bore
Figure 603





VIEW ON VANE 5 BEFORE ALTERATION

VIEW ON VANE 6 BEFORE ALTERATION



VIEW ON VANE 5 AFTER ALTERATION

VIEW ON VANE 6 AFTER ALTERATION

Pre and Post Mod CM45256
Figure 604

the pre-mod pipe (Ref. Fig. 602) has a gap all around between it and the housing, which is shown as dimension X and which is approximately 0.030 in. On the modified pipe the Stellite sleeve fills the housing bore and has only a very small clearance. (Ref. Fig. 603).

(b) If a pre-mod pipe has worn away the barrelling on one side so that the pipe end parallel portion touches the housing bore, then the gap in the opposite side will be the original 0.030 in. gap plus the movement due to the worn away locating land, giving a total gap of approximately 0.050 in. If a modified pipe wears then the gap on the opposite side will be the same as the amount of wear in the sleeve and housing.

(6) ACTION:

When it is found necessary to replace a pre-mod CM45256 No.5 bearing oil feed or scavenge pipe, it will be necessary to replace both pipes to the post mod standard. Pipes will only be issued from the mod stores in sets. All pipes to the post mod standard have been withdrawn from main stores.

A modification set will consist of the following:

Scavenge Pipe* Acceptable P/No's.	Feed Pipe+ Acceptable P/No's.
B496181	B497142
B497135	B497143
B497136	B497144
B497137	B497145
B497138	B497146
B497139	B496185

CM 45256 also introduces a housing with a Stellite sleeve fitted to it. The post mod P/No's. are as follows:

Scavenge housing P/No. B496169

Feed housing P/No. B496170

In addition, the necessary gaskets (2 off) plus seal ring (1 off) will be included in the kit.

+ See 72-01-03 Fig.404 for location details.

* See 72-01-04 Fig.404 for location details.

APPENDIX 1
ENGINE LUBRICATION SYSTEM -
SYSTEM CONTAMINATION

R 1. General

R The following tables and illustrations relate to materials contained within oil-washed compartments in the engine and are devised primarily to assist in identifying the source of engine oil system contamination.

R NOTE: The air starter is also washed by the engine oil system. As such, any materials detected that are not included in Para.2. may be from this accessory. A full list of air starter materials (not available at the time of issue) has been requested.

BP00003574/1

ALLUMINIUM ALLOYS

MATERIAL TYPE	MATL SPEC	MAIN BEARING AREAS				GEARBOX	
2.2Cu/0.9Mg/0.9Fe/0.9Ni/0.9Si/0.1Ti	DTD423					M04	M05
2.2Cu/1.5Mg/1.1Fe/1.1Ni/0.2Si/0.1Ti	RR58					M04	
2.3Cu/1.6Mg/1.1Fe/1.1Ni/0.18Si/0.07Ti	DTD5014						M05
4.4Cu/0.5Mg/0.7Si	BS.L64					M04	M05
5Cu/1.5Ni/0.25Co/0.25Fe/0.25Mn	RR350					M04	M05

COBALT BASE ALLOYS

MATERIAL TYPE	MATL SPEC	MAIN BEARING AREAS				GEARBOX	
20Cr/15W/10Ni/1.5Mn/0.1C	HAYNES 25				5		

COPPER BASE ALLOYS

MATERIAL TYPE	MATL SPEC	MAIN BEARING AREAS				GEARBOX	
Brass	Brass					M04	M05
11Sn/0.7P	Phophor bronze					M04	M05
14Sn/1.3P	HOLFOS JH17					M04	

NICKEL BASE ALLOYS

MATERIAL TYPE	MATL SPEC	MAIN BEARING AREAS				GEARBOX	
19.5Cr/13.5Co/4.2Mo/3Ti	Waspaloy			4	5		
19.5Cr/18Co/2.5Ti/1.4Al/0.1C	N90			4	5		M05
19.5Cr/2.2Ti/1.4Al/0.1C	N80A	1		4	5		
20Cr/19.7Co/5.8Mo/2.1Ti	C263				5		
36Fe/18Cr/5Mo/2TI	PE11			4	5		

STEELS

MATERIAL TYPE	MATL SPEC	MAIN BEARING AREAS				GEARBOX	
Spring steel 0.8C	DTD239					M04	M05
Spring steel 0.8C	S513		2/3			M04	M05
Spring steel	DTD326				5		M05
Spring steel	S201					M04	
Spring steel	S203						M05
Spring steel	EN584					M04	
1.4Cr/1C	BSEM521	1	2/3	4	5		
3Cr/1Mo/0.2V	BSEM630		2/3			M04	M05
3.2Cr/0.6Mo/0.5Mn/0.2C	S106	1	2/3	4	5	M04	M05

Materials and Associated Bearing Locations
Table 602

BP0000357 5/1

STEELS

MATERIAL TYPE	MATL SPEC	MAIN BEARING AREAS				GEARBOX	
3.2Cr/0.9Mo/0.5Mn/0.4C	S132					M04	
10.5Cr/6Co/0.9Mn/0.7Mo	FV535				5		
10.5Cr/0.9Ni/0.7Mn/0.6Mo	FV448						
11.5Cr/3Ni/1.75Mo/1.5Co	Jethete M190	1	2/3				
12Cr	BSEM519		2/3				M05
12Cr/0.7Mn/0.3Ai/0.22C	S62			4		M04	M05
12Cr/2.5Ni/1.7Mo/0.8AMn/0.4V	Jethete M152	1	2/3	4	5		M05
12.5Cr/0.12C	DTD525					M04	M05
13Cr	Z12C13					M04	
14Cr/5Ni/2Mo	BSEM641				5		
16.5Cr/2.5Ni	S80					M04	M05
17Cr/1Co/0.5Mo	A1SA440C		2/3				
18Cr/8.5Ni/1.2Mn/Nb or Ti	18/8 stainless	1	2/3		5	M04	M05
23Cr/14Ni	S126		2/3				
23.5Cr/11Ni/3.1W/1.6Si	BSEM515		2/3			M04	
1.2Mn/0.1Si/0.15C	EN1A		2/3			M04	
4.2Mo/4.1Cr/1V/0.8C	M50RV					M04	
1.8Ni/0.3Cr	BSEM774		2/3			M04	M05
1.8Ni/0.8Cr/0.25Mo	AMS6414					M04	
1.8Ni/0.8Cr/0.25Mo	AMS6415		2/3				M05
1.8Ni/0.55Mn/0.25Mo	MSRR6042					M04	
2.5Ni//0.5Cr/0.5Mo	S96		2/3				
4Ni/1.2Cr/0.2Mo	S82		2/3			M04	M05
4.5Ni/1.5Cr	S28		2/3		5	M04	M05
12Ni/4Cr/4Mn	S131					M04	
25.5Ni/14.7Cr/2.1Ti/1.2Mo	A286		2/3	4	5	M04	M05
26Ni/15Cr/2.1Ti/1.3Mo/0.3V	AMS5735					M04	
10W/3Cr/0.75Ni/0.4V	RBD					M04	
18W/4Cr/1V	18-4-1	1	2/3	4	5		M05

TITANIUM ALLOYS

MATERIAL TYPE	MATL SPEC	MAIN BEARING AREAS				GEARBOX	
CPT (99%)	IMI 130		2/3			M04	
CPT (99%)	IMI 160					M04	
2.5Cu	IMI 230	1					
4A1/4Mo/2Sn/05Si	IMI 550	1	2/3				M05
6A1/4V	IMI 318A TA13		2/3			M04	M05

DEPOSITION PROCESSES

MATERIAL TYPE	MATL SPEC	MAIN BEARING AREAS				GEARBOX	
✚ Chromium plate			2/3				
☐ Molybdenum nickel aluminium	MSRR9507/35		2/3				
● Nickel plate			2/3			M04	
○ Nickel chrome aluminium coating						M04	
■ Nickel graphite coating			2/3	4	5		
★ Silver plate			2/3	4	5	M04	M05
▲ Tungsten carbide coating			2/3	4		M04	

Materials and Associated Bearing Locations
Table 602 (continued)

BP0003576/1

ALUMINIUM ALLOYS

Applicability →	M01	M03	M06/2	M12	M04	M05
BS. L64					Fig. 618 & 623	Fig. 628 & 629
DTD423					Fig. 618, 621 & 622	Fig. 626
DTD5014						Fig. 626 & 628
RR58					Fig. 618, 619 & 620	
RR350					Fig. 621, 622 & 623	Fig. 626, 628 & 629

COBALT BASE ALLOYS

Applicability →	M01	M03	M06/2	M12	M04	M05
HAYNES 25				Fig. 614		

COPPER BASE ALLOYS

Applicability →	M01	M03	M06/2	M12	M04	M05
BRASS BS.249 BS.251					Fig. 621, 622 & 623	Fig. 626 & 628
HOLFOS JH17					Fig. 623	
PHOSPHOR BRONZE					Fig. 621, 622 & 623	Fig. 626

NICKEL BASE ALLOYS

Applicability →	M01	M03	M06/2	M12	M04	M05
C263				Fig. 614		
NIMONIC 80A	Fig. 605		Fig. 612	Fig. 613 & 614		
NIMONIC 90			Fig. 612	Fig. 613		Fig. 629
PE 11			Fig. 612	Fig. 614		
WASPALOY			Fig. 612	Fig. 613		

Material Type with Zone Identification
Table 603

BP00003577/1

STEELS

Applicability →	M01	M03	M06/2	M12	M04	M05
A286		Fig. 606, 607 & 609	Fig. 612	Fig. 614	Fig. 615, 616, 617, 618, 619, 620, 621, 622 & 623	Fig. 624, 625, 626, 627, 628 & 629
AISA 440C MSRR 6538		Fig. 607				
AMS 5735					Fig. 615, 616 & 617	
AMS 6414					Fig. 615, 616 & 617	
AMS 6415		Fig. 610 & 611				Fig. 624 & 626
BSEM 515		Fig. 607 & 611			Fig. 621	
BSEM 519		Fig. 610 & 611				Fig. 624 & 625
BSEM 521	Fig. 605	Fig. 608 & 609	Fig. 612	Fig. 614		
BSEM 630		Fig. 611			Fig. 616, 617 & 621	Fig. 624, 625 & 626
BSEM 641				Fig. 613		
BSEM 774		Fig. 610 & 611			Fig. 615, 616 & 617	Fig. 624, 625, 626 & 627
DTD239					Fig. 615	Fig. 625
DTD326				Fig. 613		Fig. 625
DTD525					Fig. 620	Fig. 629
EN584					Fig. 615	
FV535				Fig. 613		
FV448				Fig. 613		
JETHETE M 152	Fig. 605	Fig. 606, 607 608, 609, 610 & 611	Fig. 612	Fig. 613		Fig. 624
JETHETE M 190	Fig. 605	Fig. 608, 609 & 610				
MILD STEEL EN1A		Fig. 611			Fig. 616	
M 50					Fig. 615, 616, 617, 618 & 620	
MSRR6042					Fig. 615	
RBD					Fig. 615	

Material Type with Zone Identification
Table 603 (continued)

R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R

BP00003578/1

STEELS

Applicability →:	M01	M03	M06/2	M12	M04	M05
S 28		Fig. 610		Fig. 613	Fig. 615, 616 & 617	Fig. 624, 626, & 627
S 62			Fig. 612		Fig. 617, 619, 620 & 623	Fig. 624, 626, 628 & 629
S 80				Fig. 613	Fig. 617 & 618	Fig. 625 & 627
S 82		Fig. 608, 609, 610 & 611			Fig. 615, 616, & 617	Fig. 624, 625, 626 & 627
S 96		Fig. 610 & 611				
S 106	Fig. 605	Fig. 606, 608, 609, 610 & 611	Fig. 612	Fig. 613 & 614	Fig. 615, 616, 617, 621, 622 & 623	Fig. 624, 625, 626, 627 & 628
S 126		Fig. 607				
S 131					Fig. 621	
S 132					Fig. 616	
S 201					Fig. 623	
S 203						Fig. 627
S 513		Fig. 610 & 611			Fig. 616, 617, 619 & 621	Fig. 625
Z12C13					Fig. 619	
18.4.1	Fig. 605	Fig. 608, 609, 610 & 611	Fig. 612	Fig. 613 & 614		Fig. 624, 625, 626, 627 & 628
18/8 STAINLESS	Fig. 605	Fig. 606, 607, 608, 609 & 611	Fig. 612	Fig. 613 & 614	Fig. 615, 616, 617, 618, 619, 620, 621 & 623	Fig. 624, 625, 627, 628 & 629

TITANIUM ALLOYS

Applicability →:	M01	M03	M06/2	M12	M04	M05
IMI 130		Fig. 611				
IMI 160					Fig. 618	
IMI 230	Fig. 605	Fig. 606				
IMI 318A TA11 TA 13		Fig. 606			Fig. 617, 619 & 622	Fig. 624, 625, 626 & 628
IMI 550	Fig. 605	Fig. 608 & 609				Fig. 624

Material Type with Zone Identification
Table 603 (continued)

BP0003579/1

DEPOSITION PROCESS

Applicability →	M01	M03	M06/2	M12	M04	M05
✚ Chrome plate		Fig. 606, 610 & 611				
☐ Molybdenum nickel aluminium		Fig. 606				
● Nickel plate		Fig. 611			Fig. 616 & 620	
■ Nickel graphite coating	Fig. 605	Fig. 608 & 609	Fig. 612	Fig. 614		
○ Nickel chrome aluminium						Fig. 624
★ Silver plate		Fig. 606, 607, 608, 609, 610 & 611	Fig. 612	Fig. 613 & 614	Fig. 615, 616, 617 & 619	Fig. 624, 625, 626 & 627
▲ Tungsten carbide coating	Fig. 606	Fig. 608, 609 & 611	Fig. 612		Fig. 621, 622 & 623	Fig. 624

Material Type with Zone Identification
Table 603 (continued)

BP00003580/1

MATL SPEC	EQUIVALENT	BEARING AREAS				GEARBOX	
A286	DTD5026 MSRR6501 MSRR6532		2/3	4	5	M04	
AISA 440C	MSRR6538		2/3				
AMS 5735						M04	
AMS 6414	4340 Type					M04	
AMS 6415	MSRR6106 MSRR6114		2/3				M05
BSEM515	Crown Max MSRR6536		2/3			M04	
BSEM519			2/3				M05
BSEM521	MSRR6013	1	2/3	4	5		
BSEM630			2/3			M04	M05
BSEM641					5		
BSEM774			2/3			M04	M05
BS. L64	Dural AU4G					M04	M05
BS. 249 BS251	Brass					M04	M05
C263	BSEM810/811 MSRR7035/7036				5		
DTD239	S513 MSRR6022 EN42 DTD215					M04	M05
DTD326	Spring steel				5		M05
DTD423	RR56					M04	M05
DTD525						M04	M05
DTD5014							M05
EN1A	Mild steel		2/3				
EN584	Spring steel					M04	
FV448	BSEM529				5		
FV535	BSEM581 MSRR6519				5		
HAYNES 25					5		
IMI 130	DTD5003B		2/3				
IMI 160	MSRR8607					M04	
IMI 230	MSRR8602	1	2/3				
IMI 318A	TA11 TA 13		2/3			M04	M05
IMI 550	BSEM568 BSEM646	1	2/3				M05
Jethete M152	BSEM792 DTD5066 MSRR6503 MSRR6505 MSRR6506 MSRR6507 MSRR6509	1	2/3	4	5		M05
Jethete M190	MSRR6511	1	2/3				
M50	MSRR6083					M04	
MSRR6042			2/3			M04	
Phosphor bronze						M04	M05
RR350	BSEM578 MSRR8009					M04	M05
N80A	BSEM556	1		4	5		
N90	BSEM561 BS. HR503			4	5		M05
PE11	BSEM660			4	5		
RBD	RBD MSRR6095					M04	
RR58	AU2GN MSRR8018					M04	
RR350	BSEM578 MSRR8009					M04	M05
S28			2/3		5	M04	M05
S62				4		M04	M05
S80					5	M04	M05
S82	BSEM544 MSRR6009 MSRR6010 MSRR6024		2/3			M04	M05

List of Materials and Equivalents
Table 604

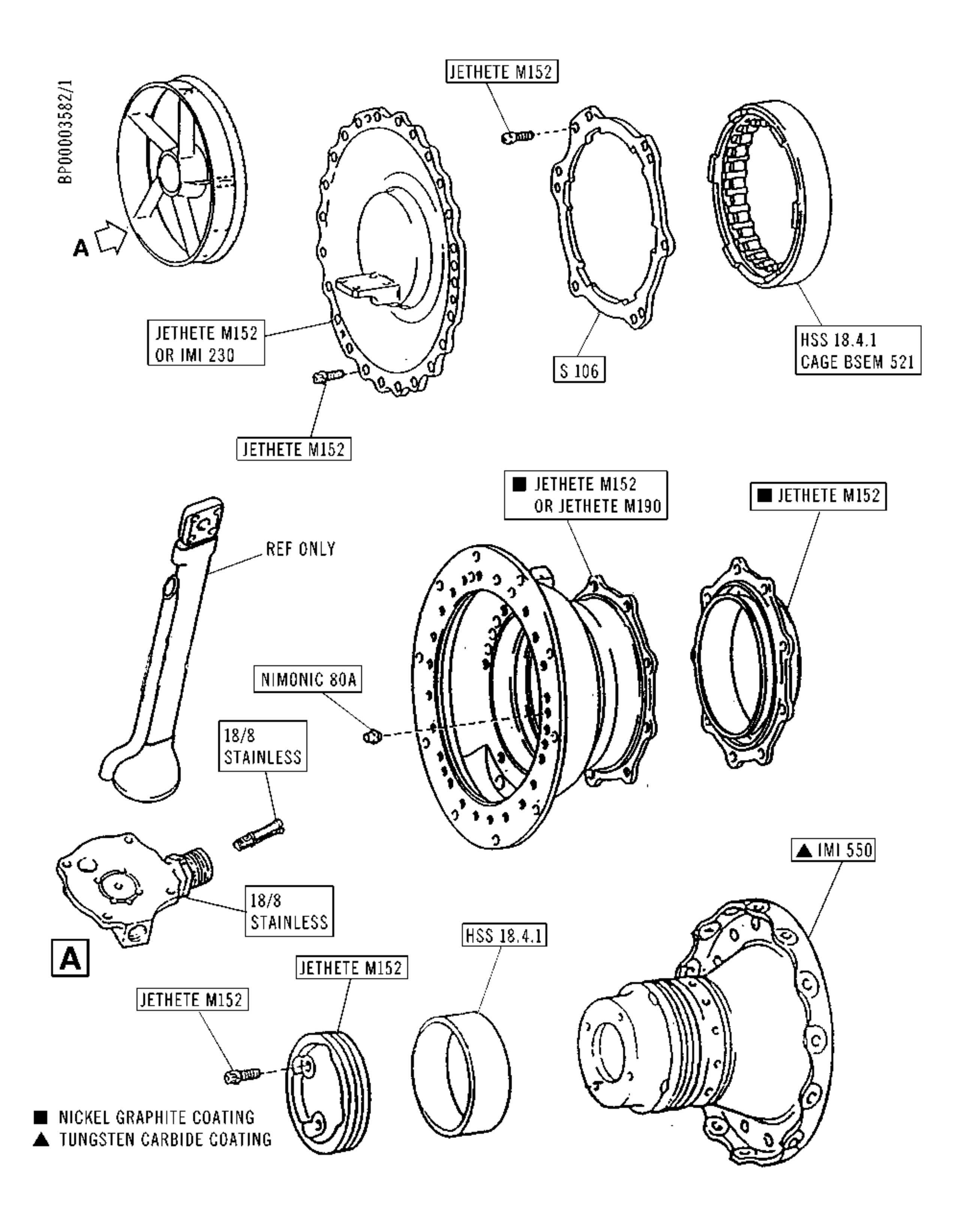
BP00003581/1

MATL SPEC	EQUIVALENT	BEARING AREAS				GEARBOX	
S96			2/3				
S106	Hykro BSEM593 MSRR6001	1	2/3	4	5	M04	M05
S126			2/3				
S131	DTD247 MSRR6018					M04	
S132	DTD730 MSRR6011					M04	
S201						M04	
S203							M05
S513	DTD215 DTD239 EN42 MSRR6022		2/3			M04	M05
Waspaloy	BSEM735 MSRR7034			4	5		
Z12C13						M04	
18.4.1	BSEM516 BSEM613 BSEM682 BSEM832 MSRR6015	1	2/3	4	5		M05
18/8 stainless	ANC3/B BSEM511 S130 S521 T55 DTD189 DTD5016 MSRR6522 MSRR6523	1	2/3	4	5	M04	M05

DEPOSITION PROCESS

	✚ Chrome plate		2/3				
MSRR9507/35	□ Molybdenum nickel aluminium		2/3				
	● Nickel plate		2/3			M04	
	○ Nickel chrome aluminium coating						M05
	■ Nickel graphite coating	1	2/3	4	5		
	★ Silver plate		2/3	4	5	M04	M05
	▲ Tungsten carbide coating	1	2/3	4		M04	M05

List of Materials and Equivalents
Table 604 (continued)



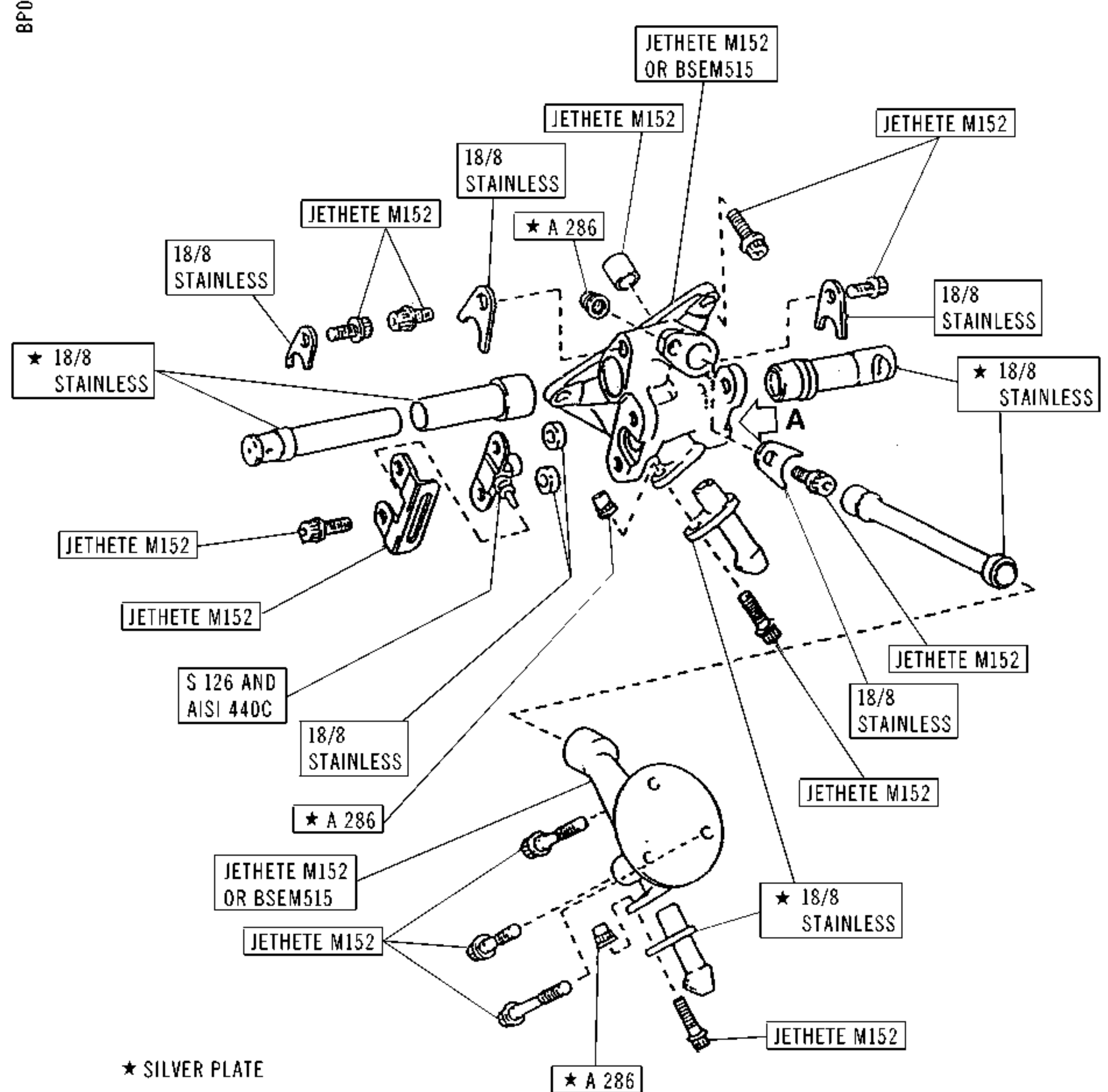
Air Intake Case - No.1 Bearing Compartment
Figure 605

BP00003583/1

★ JETHETE M152
IMI 318
OR TA 13
★ A 286
JETHETE M152
JETHETE M152
★ A 286
18/8
STAINLESS
★ JETHETE M152
JETHETE M152
JETHETE M152
18/8
STAINLESS
S 106
JETHETE M152
JETHETE M152
B
SEALOL SDS 55
A 286
JETHETE M152
+ CHROME PLATE REPAIR OR
☐ MOLYBDENUM NICKEL
ALUMINIUM COATING REPAIR
JETHETE M152
18/8
STAINLESS
JETHETE M152
IMI 230
★ 18/8
STAINLESS
18/8
STAINLESS

★ SILVER PLATE
+ CHROME PLATE REPAIR
☐ MOLYBDENUM NICKEL ALUMINIUM
COATING REPAIR

Intermediate Case Inner Case, Sump Assembly and Tubes
Figure 606



Intermediate Case - Oil Distributor and Transfer Tubes
Figure 607

BP00003585/1

JETHETE M152

★ JETHETE M152

18/8
STAINLESS

JETHETE M152

★ JETHETE M152

18/8
STAINLESS

S 106

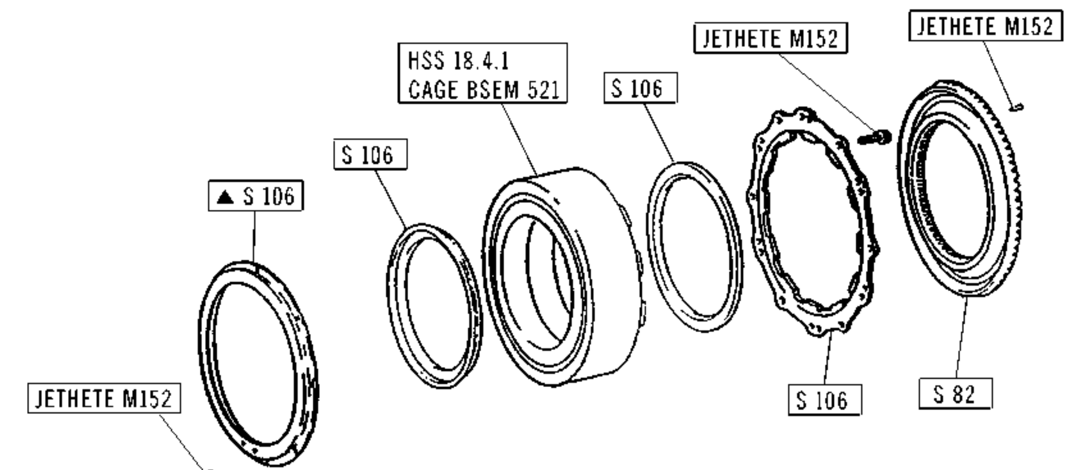
▲ S 106

▲ IMI 550

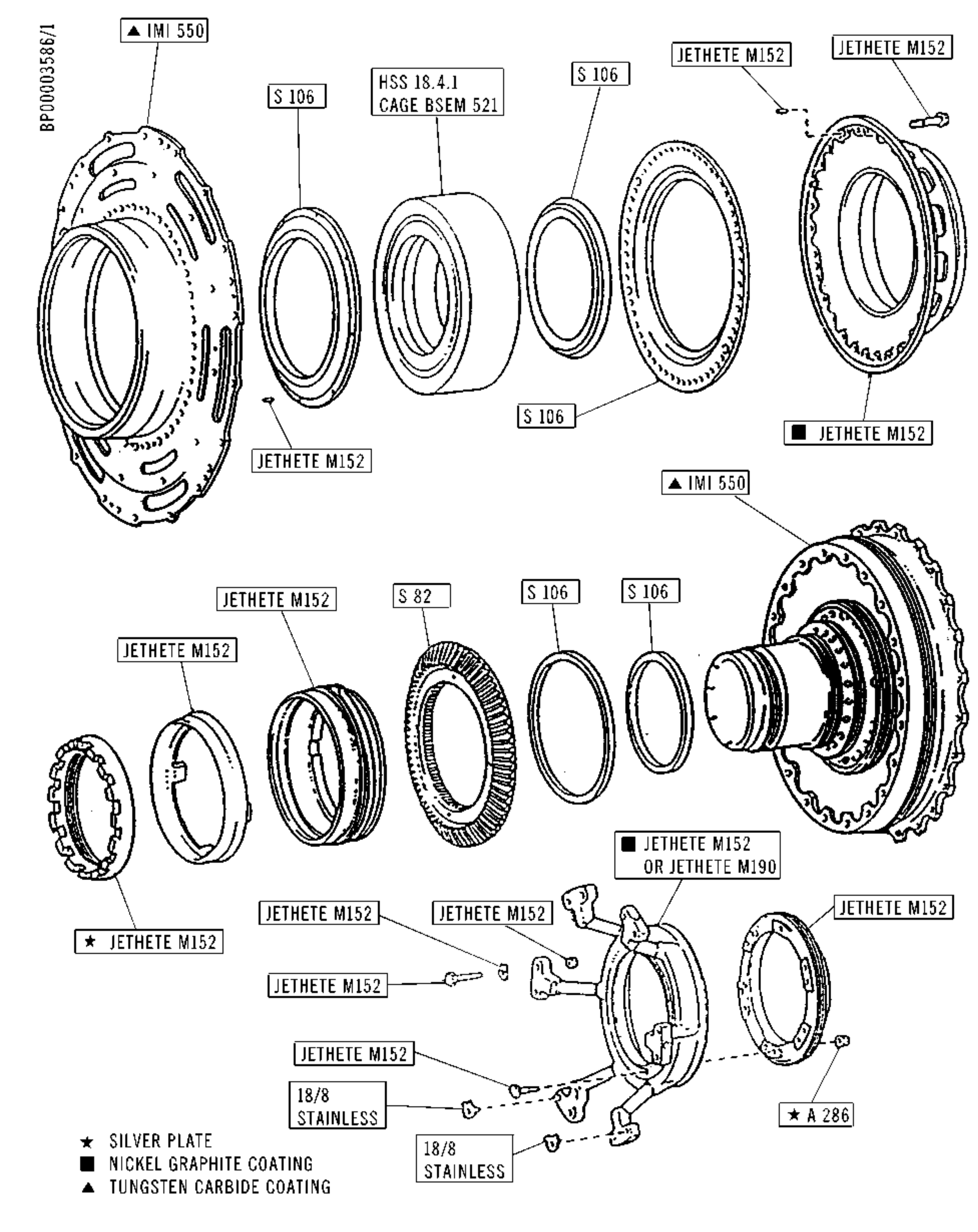
■ JETHETE M152
OR JETHETE M190

JETHETE M152

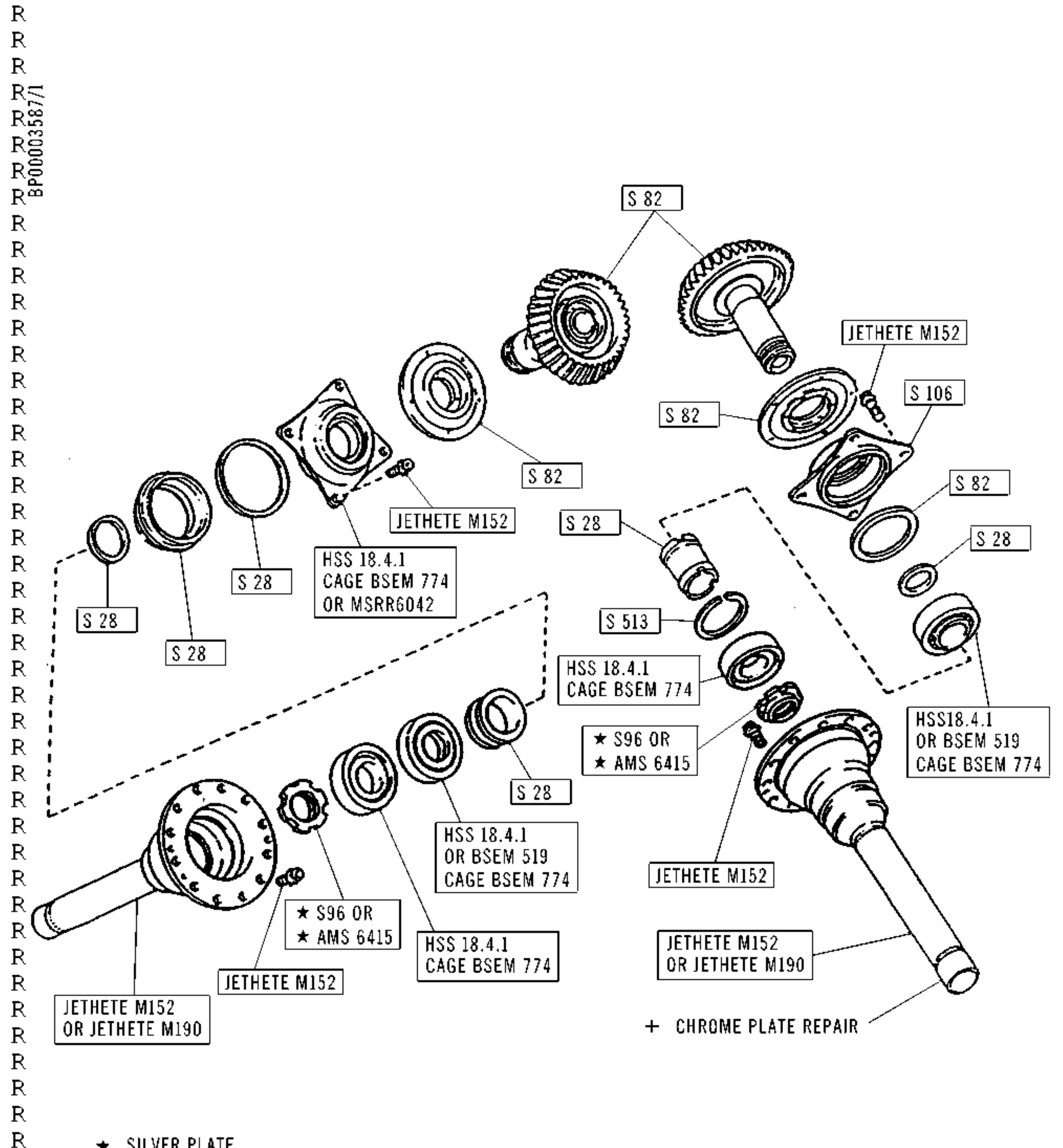
★ SILVER PLATE
■ NICKEL GRAPHITE COATING
▲ TUNGSTEN CARBIDE COATING



Intermediate Case - No.2 Thrust Bearing and Housing
Figure 608



Intermediate Case - No.3 Thrust Bearing and Housing
Figure 609



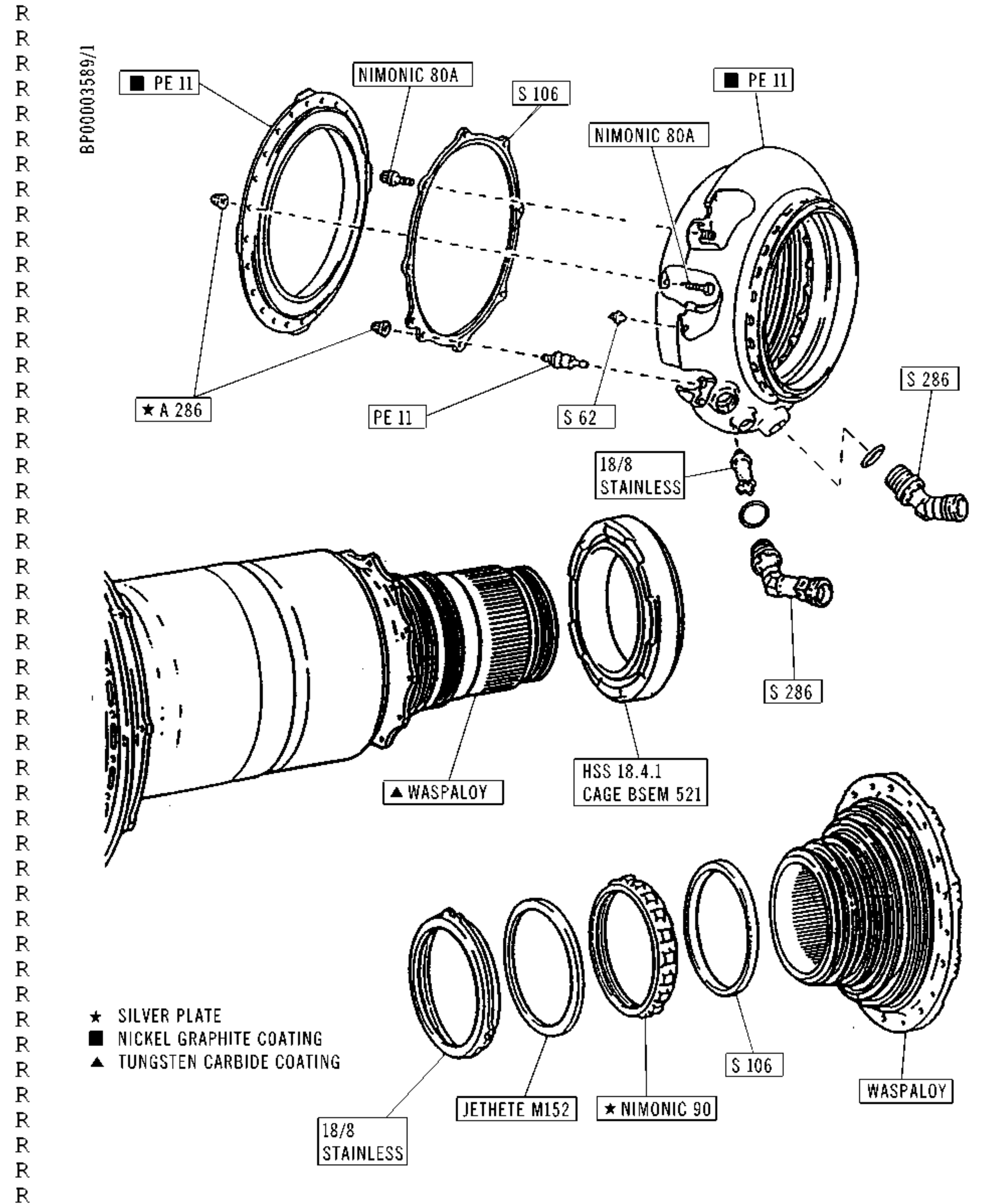
Intermediate Case - Internal Accessory Drives LH and RH
Figure 610

BP00003588/1

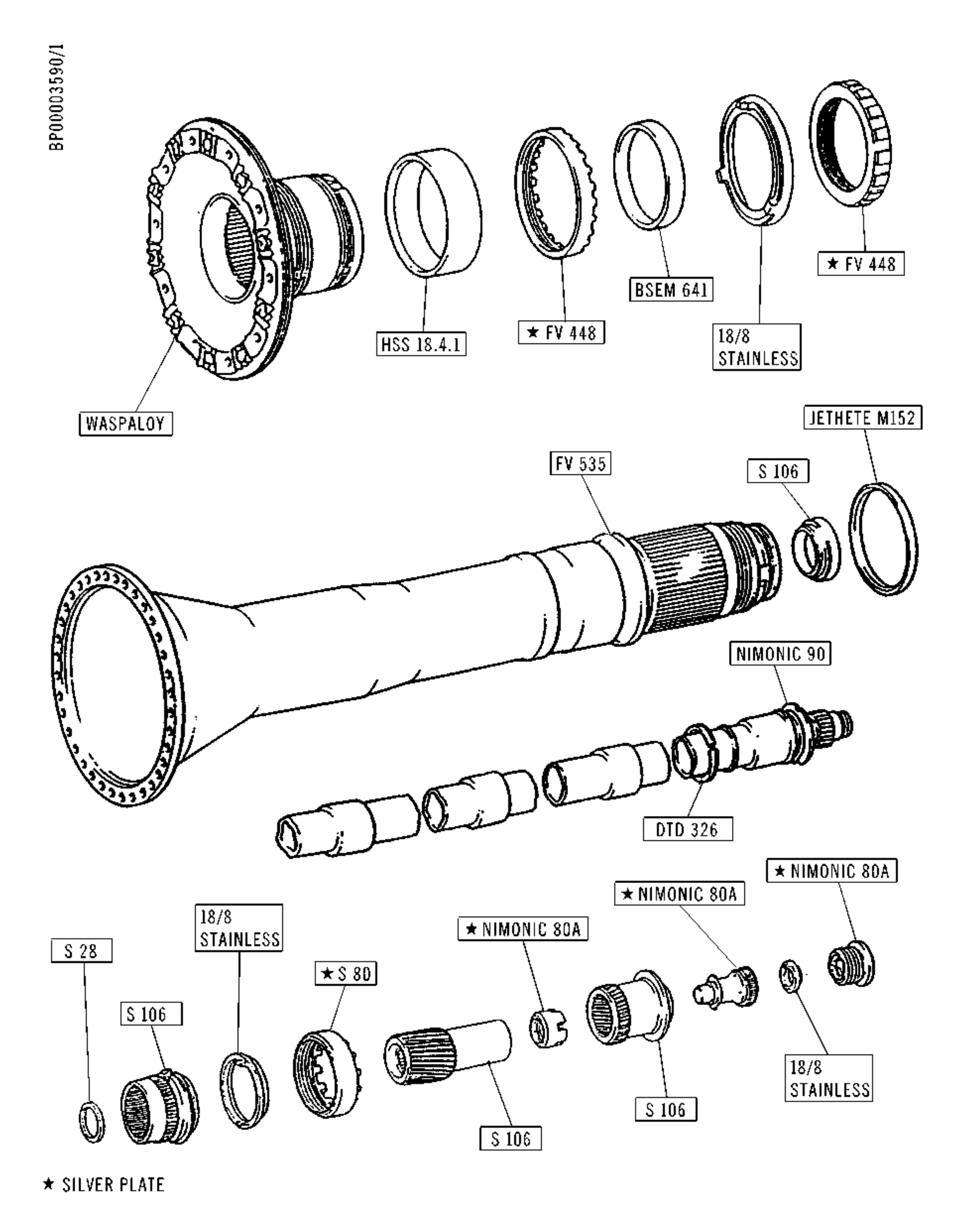
★ S96 OR
★ AMS 6415
S 513
BSEM 519
CAGE BSEM 774
BSEM 630
BSEM 630
S 513
S 82
S 82
S 513
HSS 18.4.1
CAGE BSEM 774
S 106
S 106
HSS 18.4.1
BALLS BSEM 519
CAGE BSEM 774
JETHETE M152
★ S96 OR
AMS 6415
JETHETE M152
JETHETE M152
\+ CHROME PLATE REPAIR
18/8
STAINLESS
▲ TUNGSTEN CARBIDE COATING REPAIR
BSEM 515
LP COMPRESSOR PROBE
IMI 130
●18/8
STAINLESS
POLE PIECES
MILD STEEL
JETHETE M152

★ SILVER PLATE   + CHROME PLATE   ● NICKEL PLATE   ▲ TUNGSTEN CARBIDE COATING

Intermediate Case - Internal Accessory Drive LP Tacho
Figure 611



Combustion Case - No.4 Bearing Compartment
Figure 612



Exhaust Diffuser No.5 - Bearing Rotating
Figure 613

BP00003591/1

NIMONIC 80A

HS 25

18/8 STAINLESS

HSS 18.4.1 CAGE BSEM 521

PE 11

■ PE 11

NIMONIC 80A

18/8 STAINLESS

18/8 STAINLESS

★A 286

C 263

NIMONIC 80A

C 263

C 263

★ A 286 NIMONIC 80A

★18/8 STAINLESS

S 106

★A 286

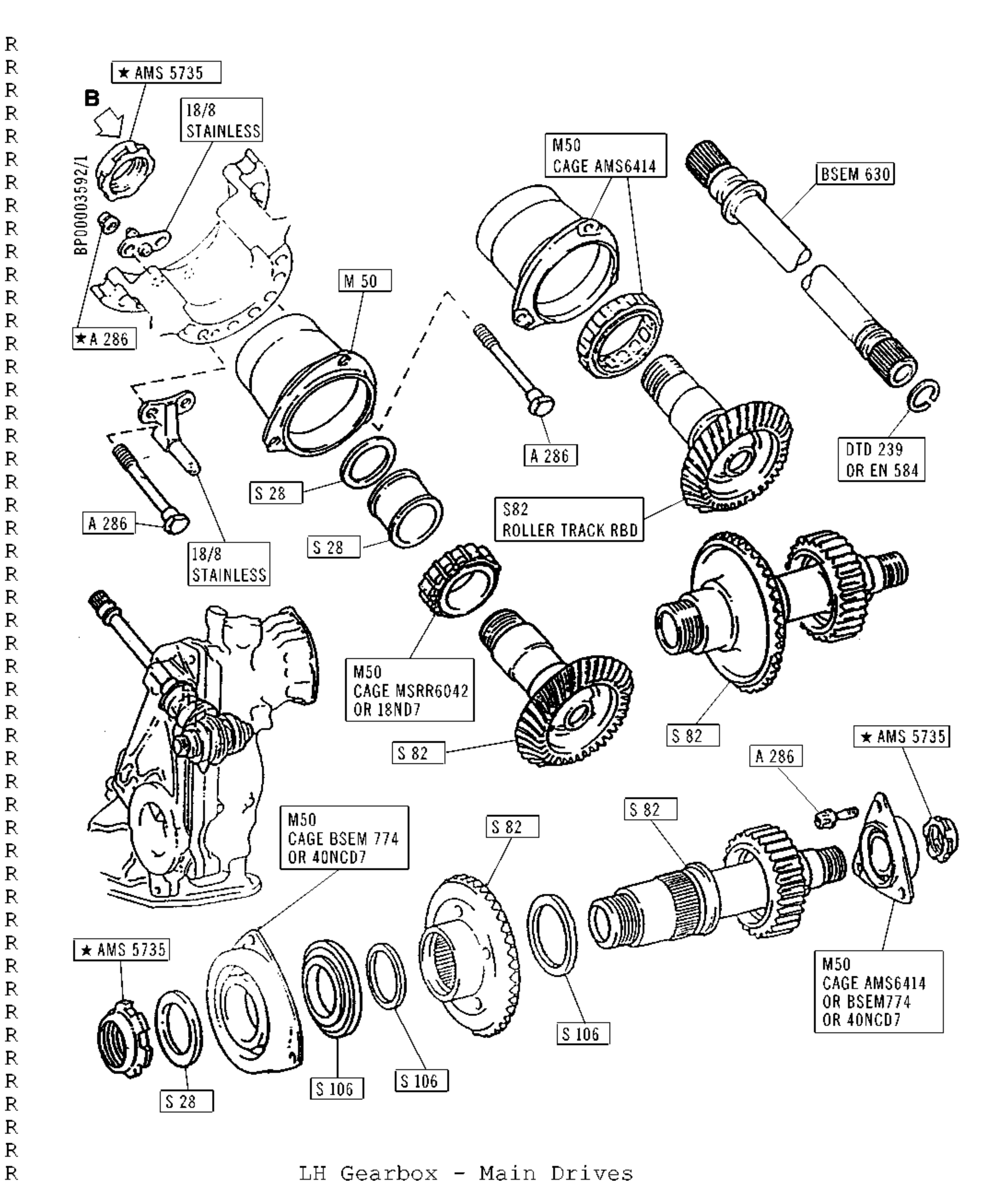
S 106

NIMONIC 80A

C 263

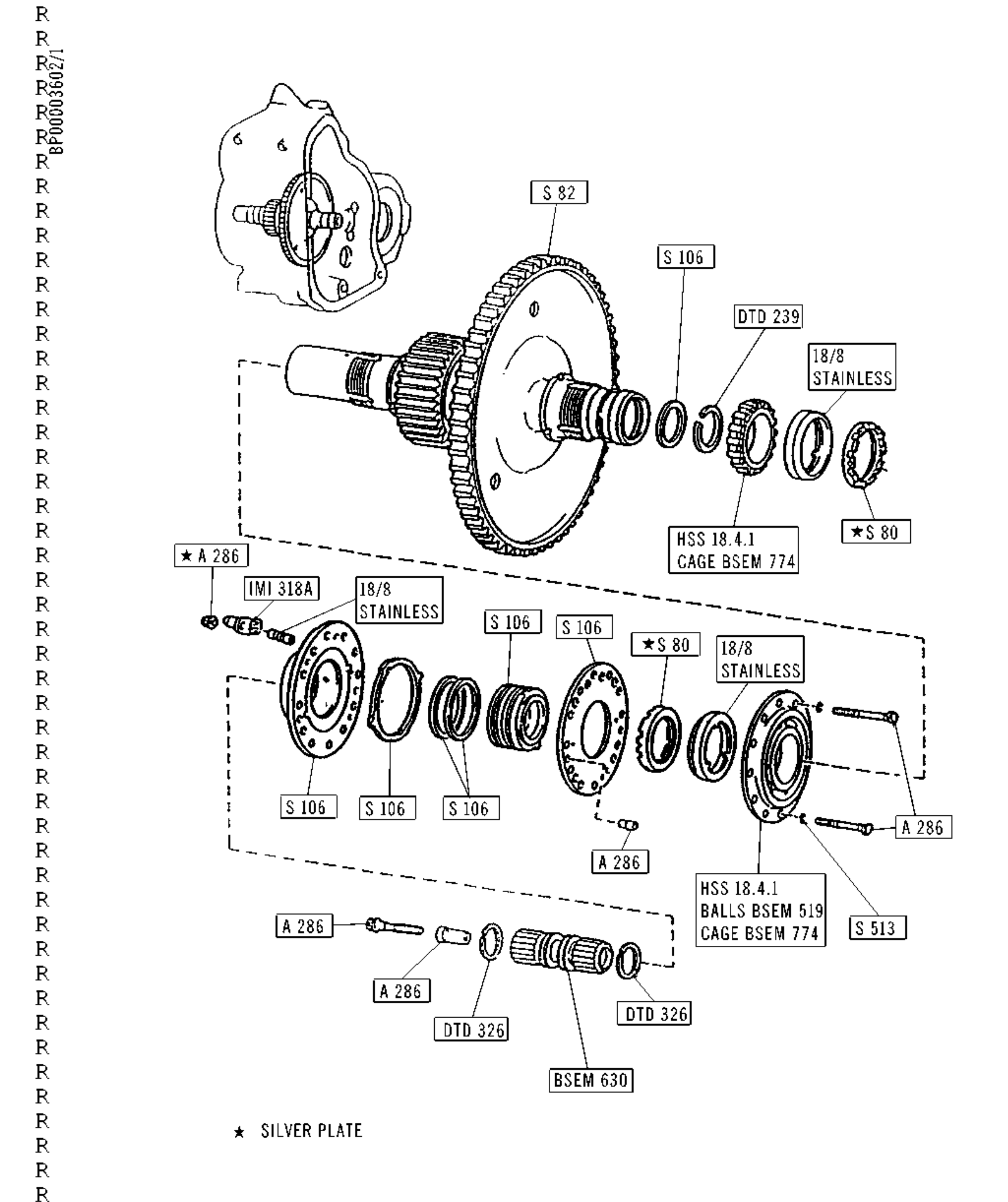
★ SILVER PLATE
■ NICKEL GRAPHITE COATING

Exhaust Diffuser - No.5 Bearing Static
Figure 614



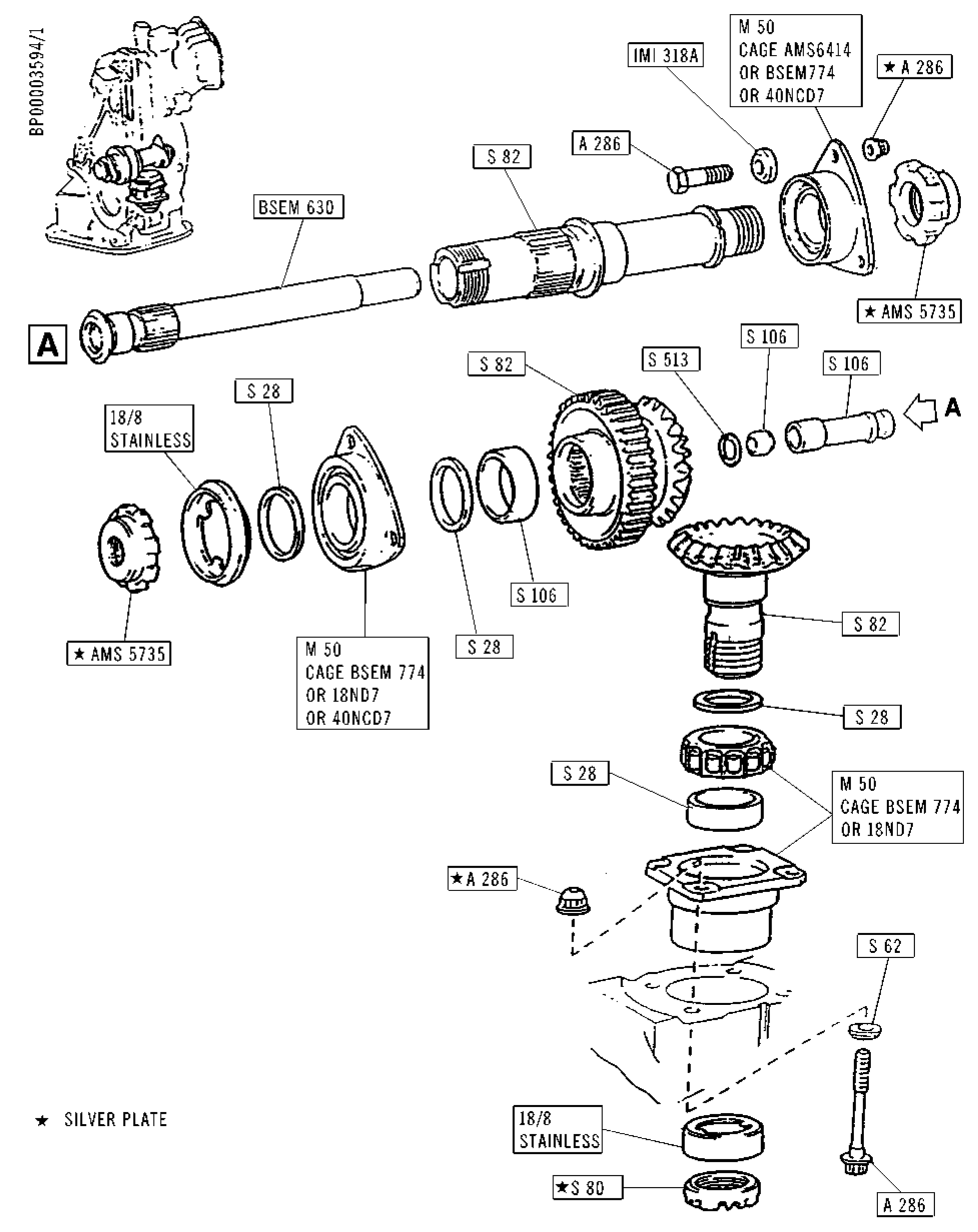
LH Gearbox - Main Drives
Figure 615

R
R
R
R
R
R



R
R

R LH Gearbox - First Stage Fuel Pump Drive and Idler Gear
R Figure 616

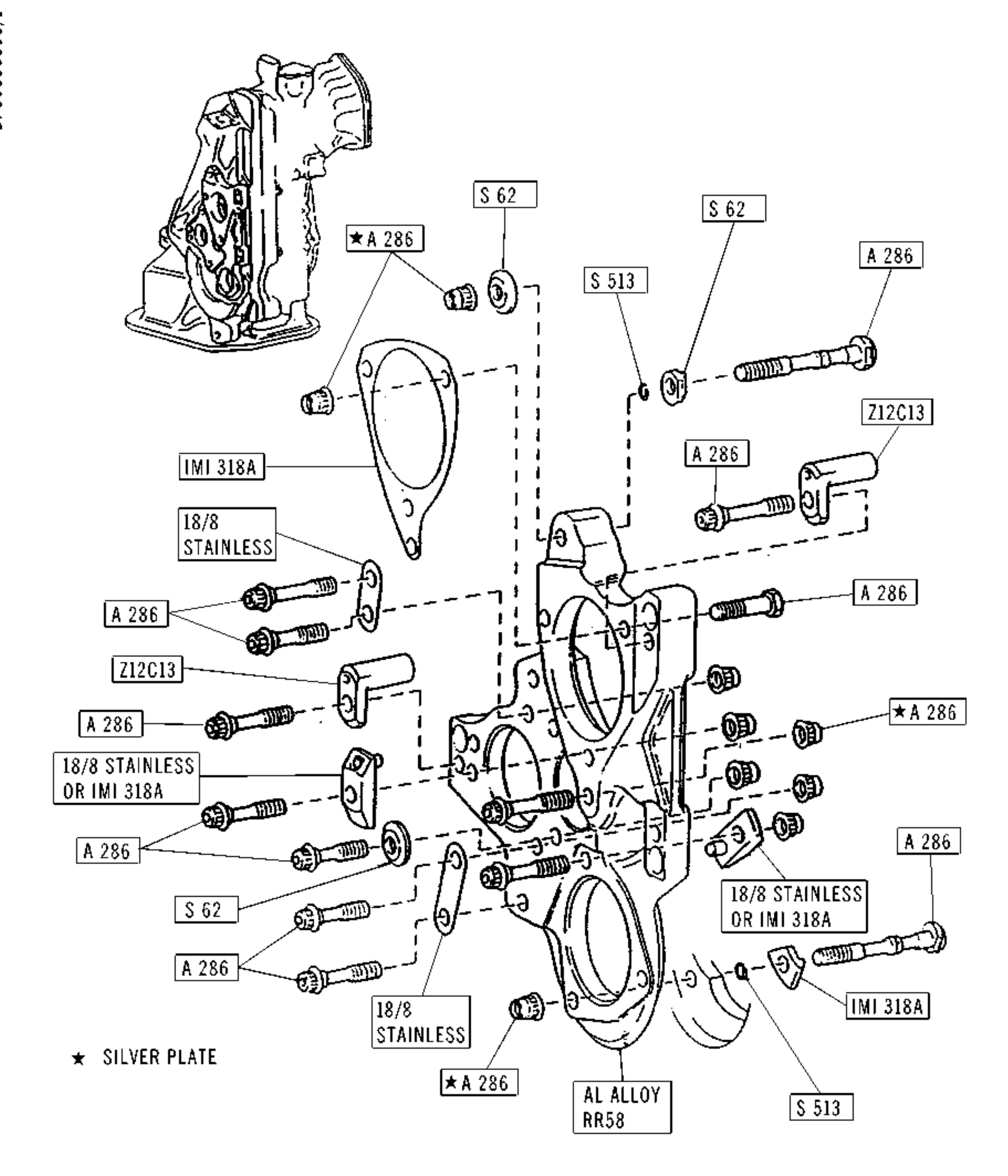


LH Gearbox - Fuel Control Unit and Oil Pump Drives
Figure 617

BP00003595/1

18/8 STAINLESS
AL ALLOY RR58
18/8 STAINLESS
A 286
18/8 STAINLESS
18/8 STAINLESS
BS. L64 OR DTD 423
A 286
18/8 STAINLESS
18/8 STAINLESS
18/8 STAINLESS
B
DTD 423
AL ALLOY RR58
A 286
A
A
18/8 STAINLESS OR DTD 423
18/8 STAINLESS
A 286
S 80
B
A 286
IMI 160

LH Gearbox Case - Front Cover
Figure 618



LH Gearbox Case - Diaphragm
Figure 619

BP0003597/1

AL ALLOY RR58

S 62 OR DTD 525

18/8 STAINLESS

A

A 286

18/8 STAINLESS

18/8 STAINLESS

18/8 STAINLESS

S 62 OR DTD 525

18/8 STAINLESS

18/8 STAINLESS

18/8 STAINLESS

AL ALLOY RR58

AL ALLOY RR58

AL ALLOY RR58

AL ALLOY RR58

A

● NICKEL PLATE

● NICKEL PLATE REPAIR

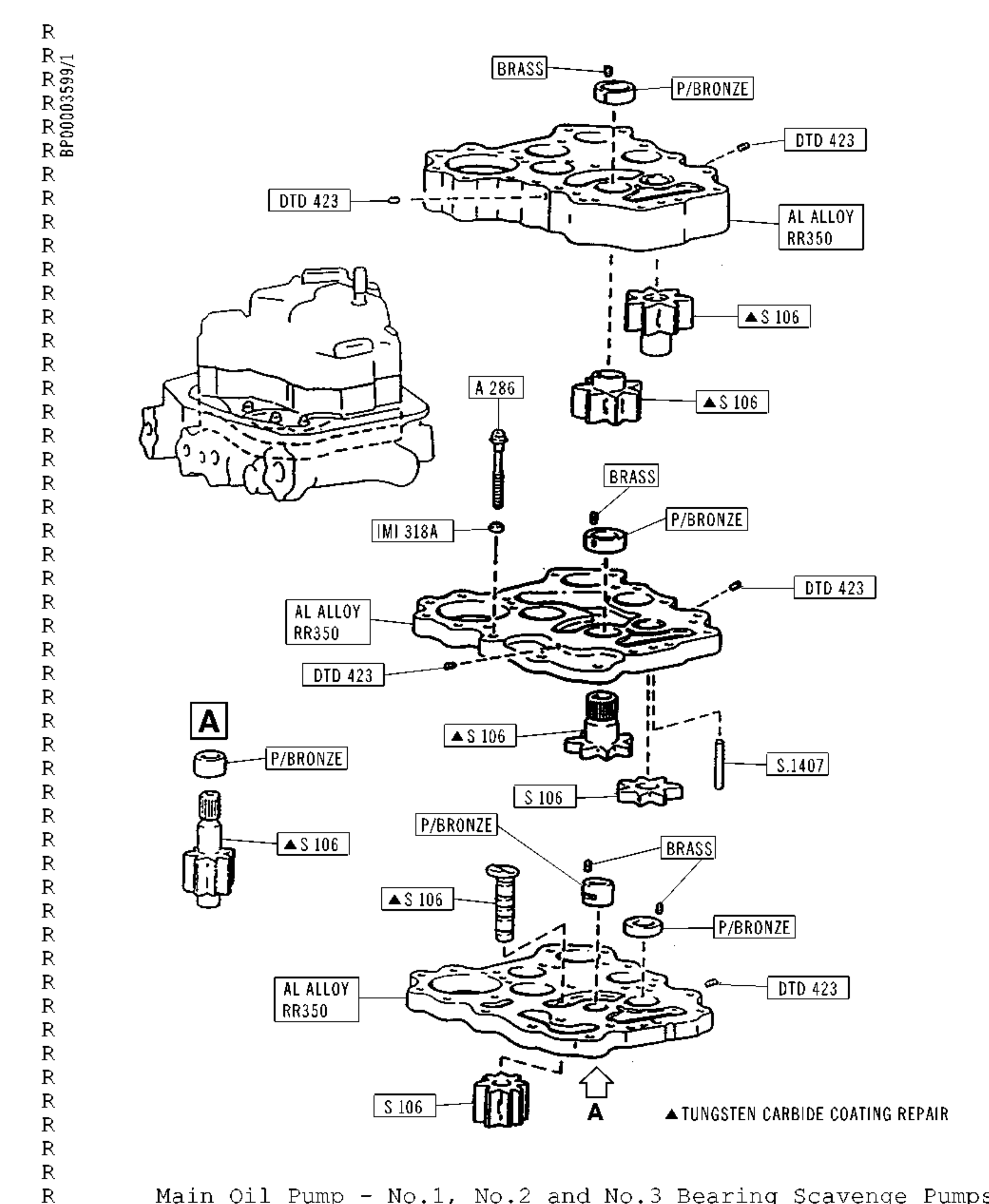
LH Gearbox Case - Oilway Filters and Oil Jets
Figure 620

BP00003598/1

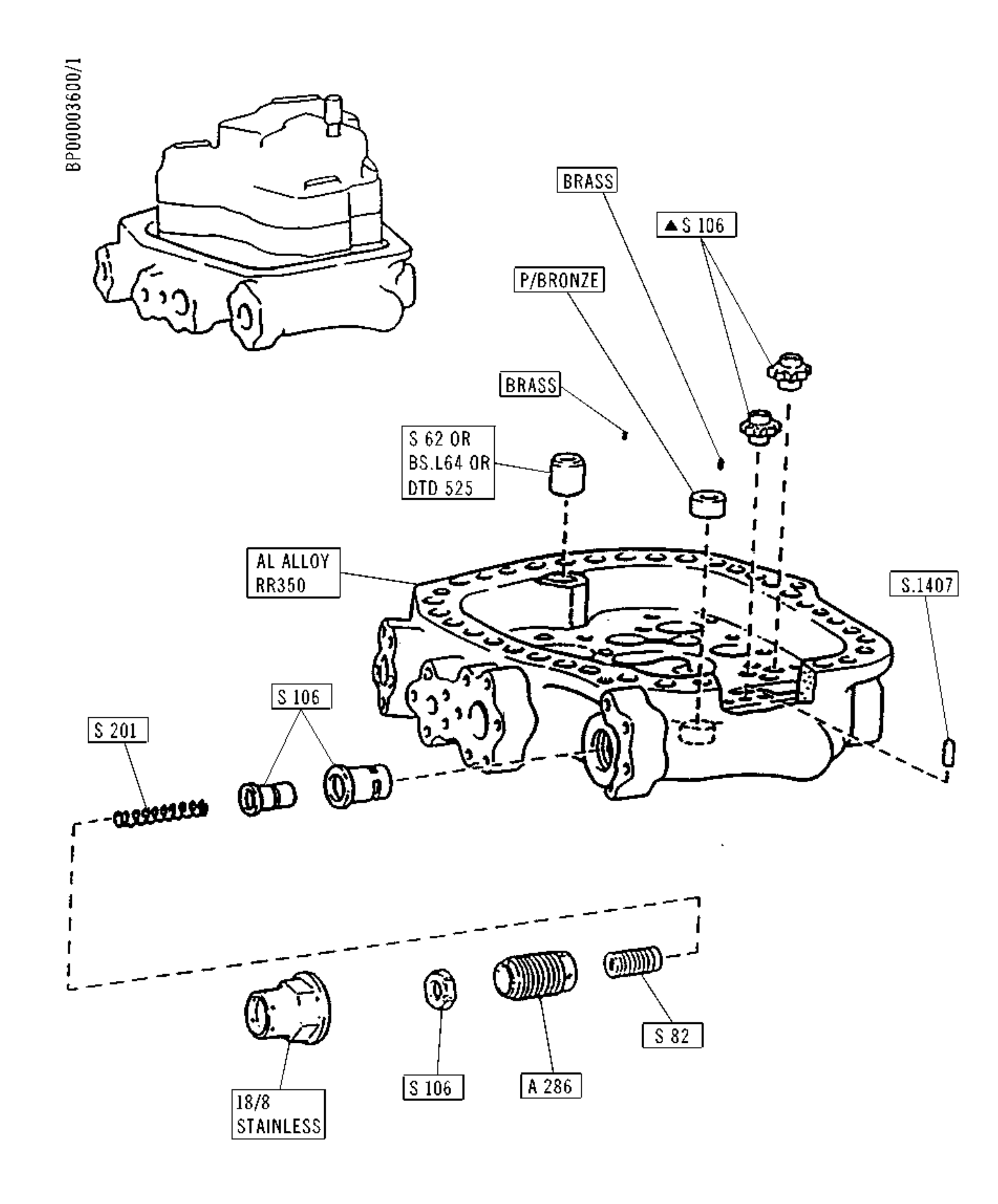
A 286
BSEM 515
A 286
A 286
BSEM 630
S 62
S 131
18/8 STAINLESS
A 286
IMI 318A
A
A 286
IMI 318A
DTD 423
ALLOY RR350
B
BSEM 515
BRASS
BRASS
S 1407
P/BRONZE
P/BRONZE
S 106
▲S 106
18/8 STAINLESS
S 131
DTD 423
S 513
BRASS
S 106
ALLOY RR350
P/BRONZE
BRASS
P/BRONZE
A 286
A 286
▲S 106
IMI 318A
IMI 318A
S 1407
B
A
▲S 106
BSEM 630

▲ TUNGSTEN CARBIDE COATING REPAIR

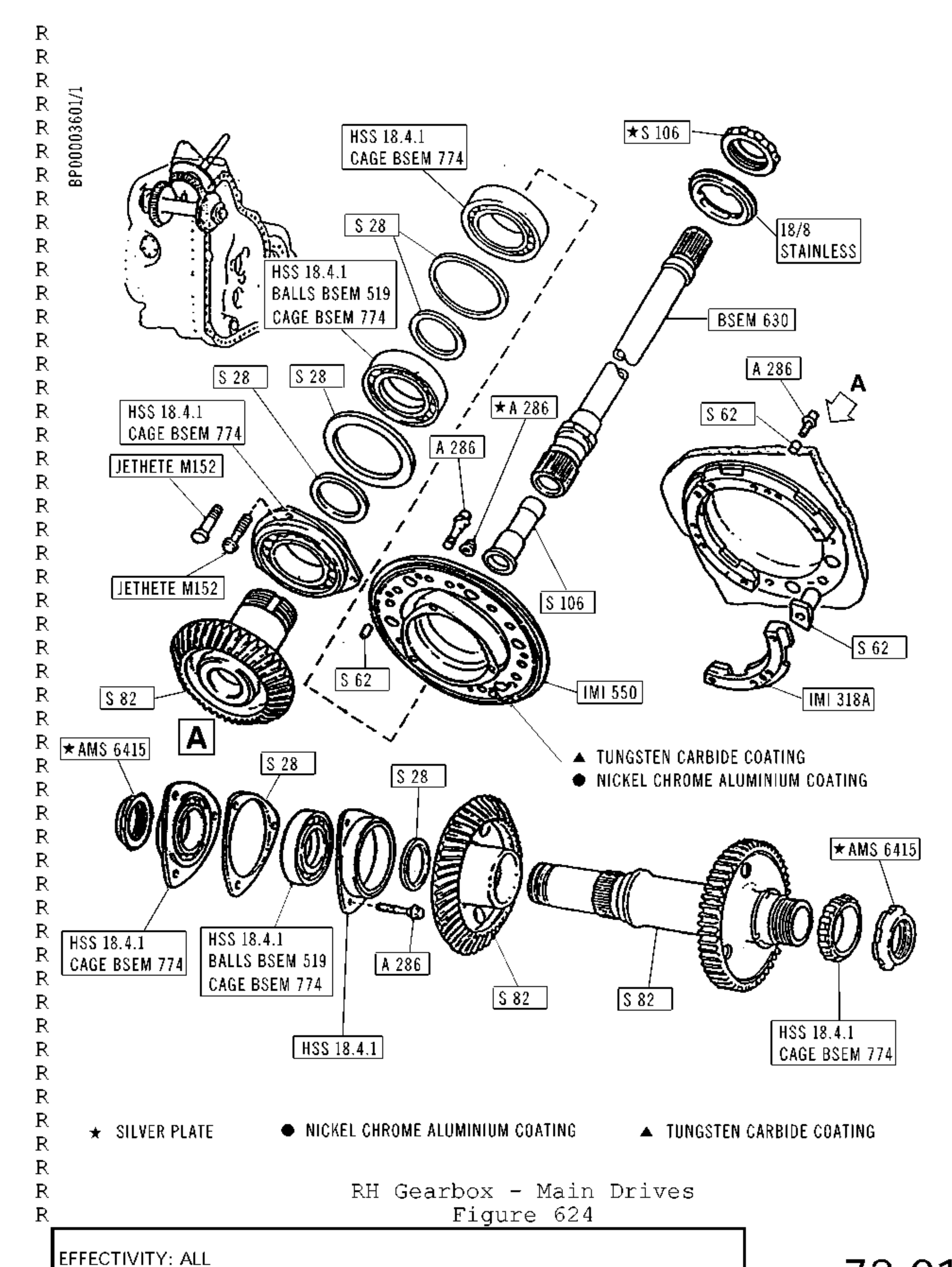
Main Oil Pump - No.4 and No.5 Bearing Scavenge Pumps
Figure 621



Main Oil Pump - No.1, No.2 and No.3 Bearing Scavenge Pumps
Figure 622



Main Oil Pump - Pressure Pump
Figure 623



RH Gearbox - Main Drives
Figure 624

★ SILVER PLATE

RH Gearbox - Air Starter and IDG Drives
Figure 625

BP00003603/1

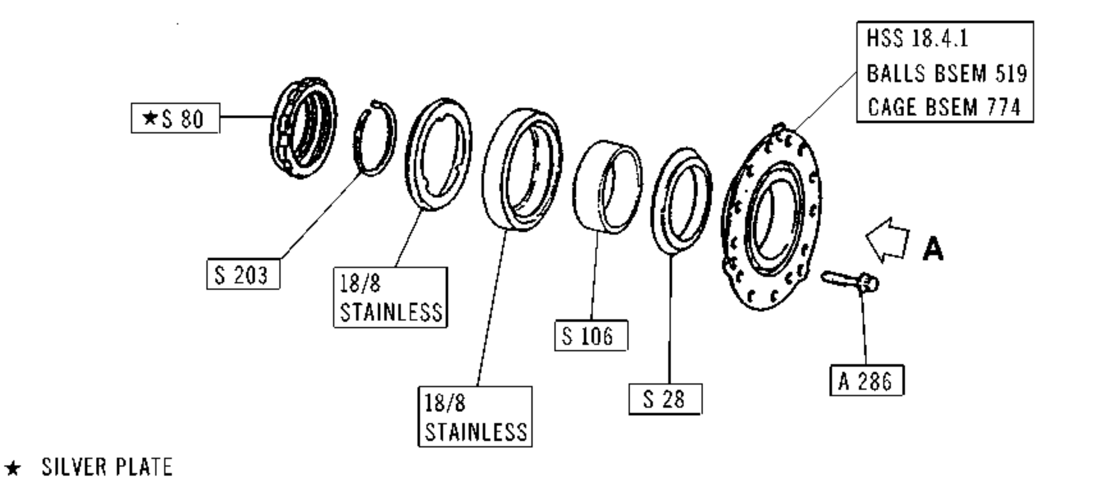
S 62
★A 286
A 286
S 62
★A 286
BSEM 630
★AMS 6415
HSS 18.4.1
CAGE BSEM 774
S 82
HSS 18.4.1
CAGE BSEM 774
HSS 18.4.1
CAGE BSEM 774
S 82
IMI 318A
★A 286
★AMS 6415
S 28
A 286
BSEM 630
AL ALLOY
RR350
DTD 423
P/BRONZE
BRASS
A 286
S 62
S 62
P/BRONZE
S 106
BRASS
S 62
AL ALLOY
RR350
DTD 5014
P/BRONZE
BRASS
S 106
S 106
★A 286
S 106
S 62
P/BRONZE
BRASS

★ SILVER PLATE

RH Gearbox - Idler Shaft and Scavenge Oil Pump
Figure 626

BP00003604/1

HSS 18.4.1
CAGE BSEM 521
S 82
A
S 28
S 106
18/8
STAINLESS
S 28
18/8
STAINLESS
S 203
★S 80
A 286



★ SILVER PLATE

RH Gearbox - Hydraulic Pump Drives
Figure 627

END OF THIS SECTION

NEXT

OIL TUBE FILTERS - SERVICING

1. General

The procedure applicable to the LP compressor front bearing scavenge oil tube filter is contained in 72-01-00, Servicing.

OIL TUBE FILTERS - REMOVAL/INSTALLATION

1. General

The procedure given in Paragraph 2 applies to the LP compressor front bearing oil feed tube filter. Refer to 72-01-00, Servicing for procedures applicable to other filters.

2. LP Compressor Front Bearing Oil Feed Tube Filter (Ref. Fig. 401)

A. Prepare to Remove Filter.

(1) Open engine bay front lower door (Ref.71-00-00, Servicing).

B. Remove Filter.

(1) Position a container under the filter location to catch oil drainage.

(2) Remove bolt and washer securing tube clamp assembly to bracket on LP compressor case front flange.

(3) Unscrew oil feed tube union nut from flange assembly on air intake case.

(4) Obtain clearance and withdraw filter from flange assembly.

(5) Measure and record the quantity of oil drained.

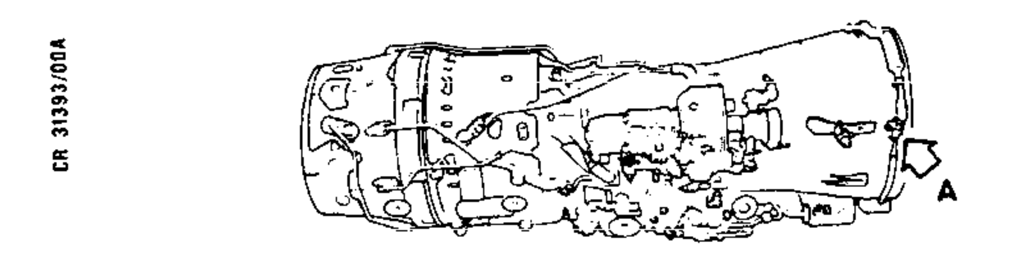
C. Install Filter.

(1) Insert filter into flange assembly.

R (2) Apply lubricant A (Ref. 70-00-01, Servicing and Storage Materials) to union connection and screw union nut to flange assembly hand tight.

(3) Apply lubricant B and secure clamp assembly to support bracket on LP compressor case front flange with a washer, bolt and clip nut. Torque-tighten bolt to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(4) Torque-tighten oil feed tube union nut to between 400 and 440 lbf in. (45 and 50 N.m). Wire-lock union nut.



CR 31393/00A

ANTI-ICING MANIFOLD

AIR INTAKE CASE

FILTER

FLANGE ASSEMBLY

LP COMPRESSOR FRONT BEARING OIL FEED TUBE

A

CMR 72 01 01 4 AAMO

Oil Feed Tube Filter and Location Detail
Figure 401

D. Complete the Installation.

(1) With oil tank full (Ref.12-13-79) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to the amount drained during the removal procedure.

(2) Close engine bay door (Ref.71-00-00, Servicing).

R (3) Do a ground run (Ref.71-00-00, Adjustment/Test) and
R check for oil leakage.

TUBES - OIL FEED, PUMP TO BEARING - REMOVAL/INSTALLATION

1. General

Paragraphs 2 to 6 detail the removal/installation procedures for oil feed tubes to the LP compressor front bearing, the compressor thrust bearings and right-hand gearbox, the LP turbine bearing oil pressure indication and the HP turbine bearing respectively. The paragraphs are sub-divided to provide individual procedures for each tube section.

Details of lubricants quoted in this chapter are contained in 70-00-01, Servicing and Storage Materials.

R CAUTION: A DRY CYCLE CHECK OR IDLE LEAK CHECK MAY NOT CONFIRM
R THAT A JOINT IS LEAK FREE.

R Following disturbance to the oil feed tubes, it is necessary to
R carry out a ground run (Ref. 71-00-00, Adjustment/Test) and
R check for oil leakage.

2. LP Compressor Front Bearing Oil Feed Tube (Ref.Fig.401)

WARNING: DISCONNECT LOW TENSION SUPPLY TO IGNITION UNITS AT LEAST ONE MINUTE BEFORE ATTEMPTING TO DISCONNECT HIGH ENERGY (HE) LEAD. ELECTRICAL DISCHARGE FROM IGNITION UNITS IS POTENTIALLY LETHAL.

A. Prepare to Remove Tube.

(1) Open engine bay front lower door (Ref.71-00-00, Servicing).

(2) Disconnect low tension (LT) ignition lead and wait at least one minute before disconnecting HE leads.

(3) Disconnect both HE leads from their respective ignition unit connections.

(4) Detach the first two clamps retaining each of the HE leads.

(5) Remove front section, scavenge flange to tube connection, of LP compressor front bearing scavenge tube (Ref.72-01-04, Removal/Installation).

(6) Remove front section, air intake case adapter to flanged connector, of air intake cone adapter to outlet seal plate (left-hand) vent tube (Ref.75-02-09, Removal/Installation).

(7) Remove front section, filter outlet to tube junction,

CR 31454/00B

LP AND HP COMPRESSOR THRUST BEARINGS OIL FEED TUBE

GASKET (SB 79-3)

FLAT WASHER

WIRE LOCKING BOLT

CLIPNUT

OIL PUMP

FLAT WASHER

A

SPACER

FLAT WASHER

AIR INTAKE CASE

CLIPNUT

FLANGE ASSEMBLY

STRAINER ELEMENT

CMR 72 01 03 4 AAM0

LP Compressor Front Bearing Oil Feed Tube
Figure 401

of first stage pump to second stage pump tube (Ref. 73-13-01, Removal/Installation).

B. Remove Tube.

(1) Position a container to catch oil drainage and unscrew union nut of LP and HP compressor thrust bearings oil feed tube.

(2) Remove bolts securing tube flange to oil pump.

(3) With container positioned under connection, unscrew tube union nut from flange assembly on air intake case.

(4) Detach tube clamp assemblies and remove tube from engine.

(5) Withdraw strainer assembly from its housing.

(6) On SB.79-3 standard engines, remove gasket from oil pump flange.

(7) Measure and record the quantity of oil drained.

C. Install Tube.

(1) Apply lubricant A to LP and HP compressor thrust bearings oil feed tube union nut and union connection at flange assembly. Apply lubricant B to attachment bolts.

(2) Check that the strainer assembly is clean and unobstructed. Insert strainer into housing.

(3) Position tube on engine with a gasket placed between tube flange and oil pump. Retain tube flange and electrical cable bracket to oil pump with five bolts lightly tightened. Position the wire-locking bolt as shown.

(4) Connect and screw on the LP and HP compressor thrust bearings oil feed tube union nut hand-tight.

(5) Connect and screw union nut to flange assembly on air intake case.

(6) Attach and secure tube clamp assemblies to support brackets as shown. Torque-tighten bolt securing tube clamp assembly and LP compressor front bearing oil scavenge tube clamp assembly to between 67 and

73 lbf in. (7,6 and 8,2 N.m). Torque-tighten remaining bolts to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(7) Torque-tighten tube flange securing bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(8) Torque-tighten LP and HP compressor thrust bearings oil feed tube union nut to between 400 and 440 lbf in. (45 and 49 N.m). Wire-lock union nut to tube flange securing bolt.

(9) Torque-tighten union nut at flange assembly to between 400 and 440 lbf in. (45 and 49 N.m). Wire-lock union nut.

D. Complete the Installation.

(1) Install front section, filter outlet to tube junction, of first stage pump to second stage pump tube (Ref. 73-13-01, Removal/Installation).

(2) Install front section, air intake case adapter to flanged connector, of air intake case adapter to outlet seal plate (left-hand) vent tube (Ref.75-02-09, Removal/Installation).

(3) Install front section, scavenge flange to tube connection, of LP compressor front bearing scavenge tube (Ref. 72-01-04, Removal/Installation).

(4) Connect HE leads, hand-tight, to their respective ignition unit connections.

(5) Secure the first two clamps of both leads to their supports (Ref.74-21-01, Removal/Installation) and lightly tighten nuts and bolts.

(6) Torque-tighten HE lead end union nuts, Pre S.B.74-5 standard, to between 10 and 15 lbf ft (13,6 and 20,3 N.m). Torque-tighten HE lead end nuts, S.B.74-5 standard, to between 20 and 25 lbf ft (27 and 34 N.m). Wire-lock lead nuts together.

(7) Torque-tighten clamp nut and bolts to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(8) Connect, tighten and wire-lock LT supply lead.

(9) With the oil tank full (Ref.12-13-79, Servicing) and the overflow drain connection drain plug installed,

add a quantity of oil to the tank equivalent to that drained during removal procedure.

(10) Close engine bay doors (Ref.71-00-00, Servicing).

(11) Carry out ignition system test (Ref.74-00-00, Adjustment/Test).

3. LP and HP Compressor Thrust Bearings and Right-Hand Gearbox Oil Feed Tubes (Ref.Fig.402)

A. Prepare to Remove Tubes.

(1) Open engine bay front lower door (all engines) to gain access to the tubes detailed in paragraphs B and D. Open No.2 and No.4 engine bay front doors and remove engines No.1 and No.3 to gain access to the tube detailed in paragraph C. Refer to 71-00-00, Servicing.

B. Oil Feed Tube (Oil Pump to Union Connection).

(1) Remove tube.

(a) Comply with the requirements of paragraph A.

(b) Position a container to catch oil drainage and unscrew union nuts at each end of tube.

(c) Detach clamp assembly from bracket on LP compressor case and remove tube from engine.

(d) Measure and record the quantity of oil drained.

(2) Install tube.

(a) Apply lubricant A to union connections, position tube on engine and screw on union nuts hand-tight.

(b) Attach and secure tube clamp assembly and electrical cable clamp to support bracket with a bolt and nut torque-tightened to between 85 and 95 lbf in. (9,6 and 10,7 N.m) with lubricant B applied.

(c) Torque-tighten both union nuts to between 400 and 440 lbf in. (45 and 49 N.m). Wire-lock union nuts.

(d) Comply with the requirements of paragraph E.

C. Oil Feed Tube (Union Connection to Intermediate Case).

(1) Remove tube.

CR 3145/00C

FORWARD

INTERMEDIATE CASE

A

B

C

D

RIGHT-HAND GEARBOX
OIL FEED TUBE

UNION CONNECTIONS

OIL PUMP

CMR 72 01 03 4 DAMO

FLAT WASHER

FLAT WASHER

GASKET (SB 79-3)

Thrust Bearings and Right-Hand Gearbox Oil
Feed Tubes
Figure 402

R

(a) Comply with the requirements of paragraph A.

(b) Position a container to catch oil drainage and unscrew right-hand gearbox oil feed tube union nut from connection on tube, then unscrew the union nuts at each end of the tube.

(c) Detach clamp assemblies from support brackets and remove tube from engine.

(d) Measure and record quantity of oil drained.

(2) Install tube.

(a) Apply lubricant A to union connections and lubricant B to attachment bolts.

R (b) Ensure that restrictor of an engine to
R S.B.593-72-8562-146 standard is in position, is
R clean and free from obstruction and position
R tube on engine and screw on the three union nuts
R hand tight.

(c) Attach and secure tube clamp assembly items; torque-tighten nut to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(d) Torque-tighten right-hand gearbox oil feed tube union nut to connection on tube to between 310 and 340 lbf in. (35 and 38 N.m).

(e) Torque-tighten union nuts at each end of tube to between 400 and 440 lbf in. (45 and 49 N.m).

(f) Wire-lock the three union nuts.

(g) Comply with the requirements of paragraph E.

D. Right-Hand Gearbox Oil Feed Tube.

(1) Remove tube.

(a) Comply with the requirements of paragraph A.

(b) Position a container to catch oil drainage and unscrew tube union.

(c) Remove bolts securing tube flange to right-hand gearbox and remove tube from engine. On SB.79-3 standard engines, remove the gasket from the gearbox flange.

(d) Measure and record quantity of oil drained.

(2) Install tube.

(a) Apply lubricant A to union connection and lubricant B to flange attachment bolts.

(b) Hold tube on engine with a new gasket placed between tube flange and right-hand gearbox and retain flange and interposed gasket with five bolts lightly tightened.

(c) Screw on union nut hand-tight.

(d) Torque-tighten five bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m) and the union nut to between 310 and 340 lbf in. (35 and 38 N.m). Wire-lock union nut.

(e) Comply with the requirements of paragraph E.

E. Complete the Installation.

(1) With the oil tank full (Ref.12-13-79, Servicing) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to that drained during removal procedure.

(2) Install engines No.1 and No.3 and on completion of work close engine bay doors (Ref.71-00-00, Servicing).

R 4. LP Turbine Bearing Oil Feed Tube

A. General.

The LP turbine bearing oil feed tube comprises of three tube sections, front and rear tubes mounted on the outside of the engine and an internal tube contained within vane No.6 of the turbine exhaust diffuser. The procedures for the front and rear external tubes are detailed in paragraphs C. and D. respectively and for the internal tube in paragraph E.

The procedures for the internal tube section incorporate the requirements of SB.OL.593-72-A119 (which includes S.B.OL.593-72-102 and S.B.OL.593-72-121) and details the requirements of pre and S.B.OL.593-72-101.

B. Tools and Equipment.

Spanner	S3S11337000
Spanner	S3S11338000
Torque adapter	S3S11356000
Holder	S3S11361000
Nut runner...	S3S11340000

C. Front External Tube (Ref. Fig. 403)

(1) Remove tube.

(a) Open engine bay lower doors (Ref. 71-00-00, Servicing).

(b) Remove distribution and dump valve to drains tank tube (Ref. 71-73-05, Removal/Installation).

(c) Position a container to catch oil drainage and unscrew union nuts at each end of tube.

(d) Detach tube clamp assemblies from support brackets and remove tube from engine.

(e) Measure and record the quantity of oil drained.

(2) Install tube.

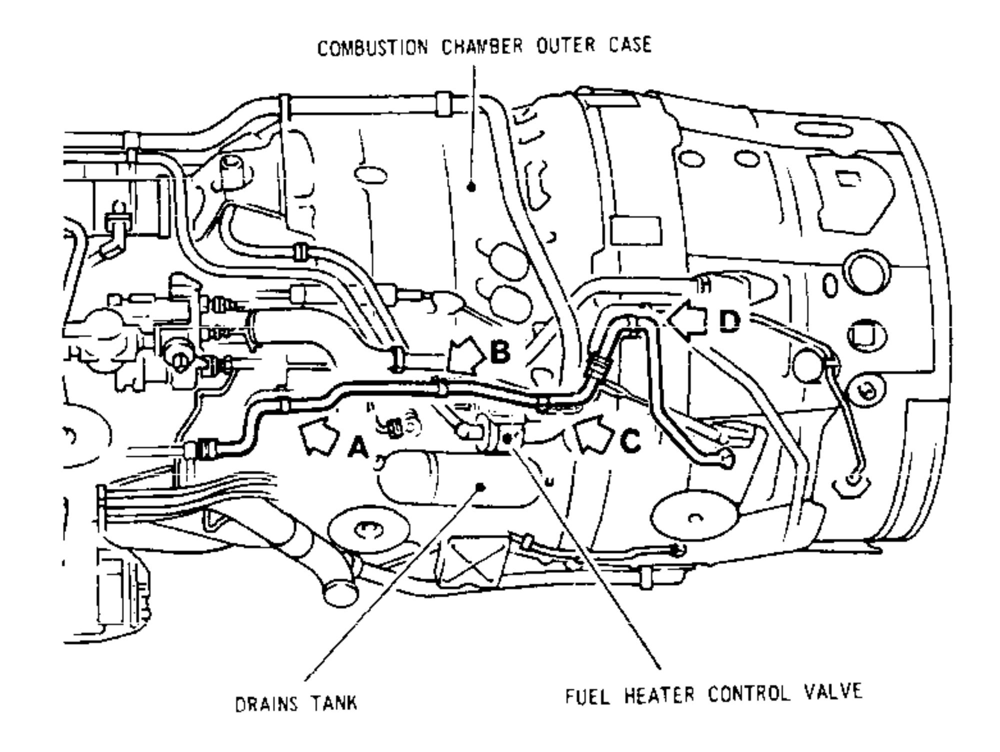
(a) Apply lubricant A to union connections and lubricant B to attachment bolts.

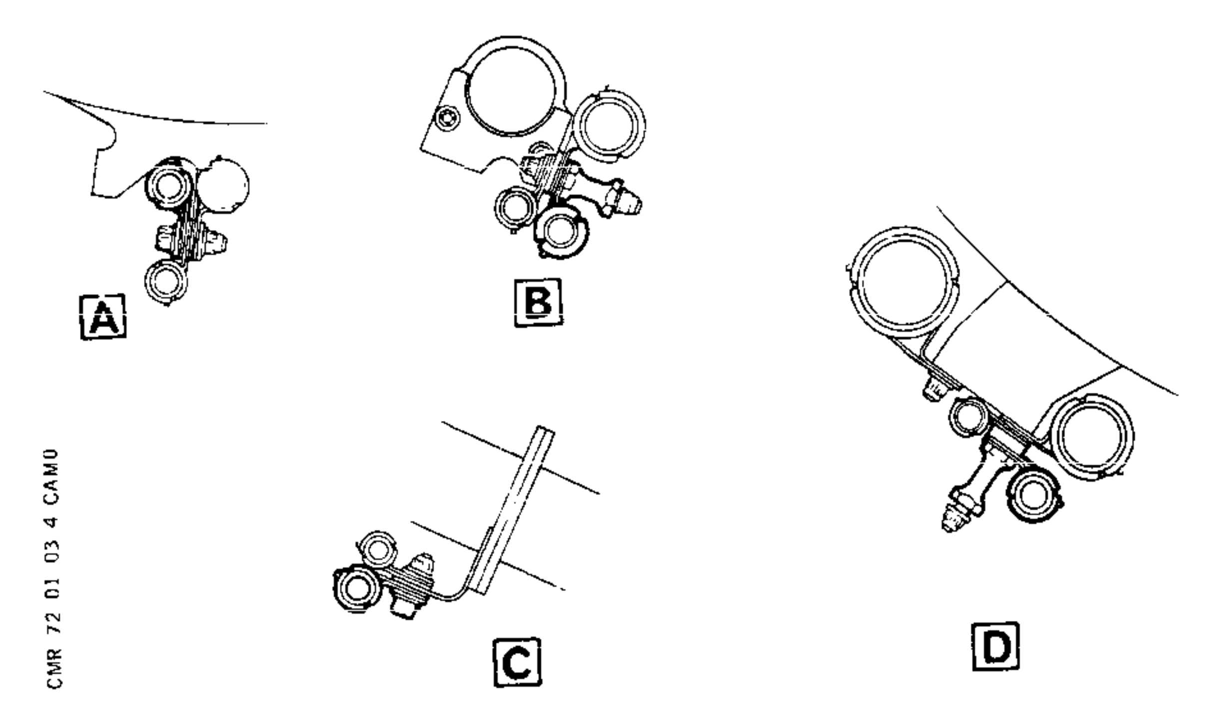
(b) Position tube on engine and screw on the union nuts hand-tight.

(c) Attach and secure tube clamp assemblies to bracket on HP compressor delivery case rear flange as shown. Torque-tighten nut to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(d) Attach and secure tube clamp assemblies to LP turbine bearing hot vent tube retaining plate and bracket on fuel heating air tube joint as shown. Torque-tighten nuts to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(e) Torque-tighten the two union nuts to between 280 and 310 lbf in. (32 and 35 N.m). Wire-lock union nuts.





CMR 72 01 03 4 CAM0

LP Turbine Bearing Oil Feed Tubes
Figure 403

R

(f) Install distribution and dump valve to drains tank tube (Ref. 71-73-05, Removal/Installation).

(g) Comply with the requirements of paragraph F.

D. Rear External Tube (Ref. Fig. 403).

(1) Remove tube.

(a) Open engine bay lower doors (Ref. 71-00-00, Servicing).

(b) Position a container to catch oil drainage and unscrew the union nuts at each end of tube.

(c) Detach tube clamp assembly from support bracket and remove tube from engine.

(d) Measure and record the quantity of oil drained.

(2) Install tube.

(a) Apply lubricant B to union connection on turbine exhaust diffuser and lubricant A to tube joint union connection.

(b) Position tube on engine and screw on union nuts hand-tight.

(c) Attach and secure tube clamp assembly to pillar bolt on support bracket with a flat washer and nut torque-tightened to between 67 and 73 lbf in. (7,6 and 8,2 N.m) with lubricant B applied.

(d) Torque-tighten union nut at turbine exhaust diffuser connection to between 490 and 550 lbf in. (55 and 62 N.m).

(e) Torque-tighten union nut at tube joint to between 280 and 310 lbf in. (32 and 35 N.m).

(f) Wire-lock both union nuts.

(g) Comply with the requirement of paragraph F.

E. Internal Tube (Ref. Fig. 404)

(1) Remove tube.

(a) Open engine bay rear doors (Ref. 71-00-00, Servicing).

(b) Remove the reheat injection system (Ref.73-12-06, Removal/Installation).

(c) Remove the jet pipe thermocouple harness and lead-out (Ref. 77-21-02, Removal/Installation).

(d) Remove rear external tube section as detailed in paragraph D. (1).

(e) Remove the nut and bolt clamping the cover to the tube assembly and the two bolts securing the cover to the seal housing. Draw the cover along the tube away from the seal housing and expose the barrel nut.

(f) Locate one of the spanners on the barrel nut, insert the holder between the spanner and the tube shoulder and engage it with the plate on the tube. Attach drive to spanner and loosen the nut, using the spanners alternately as required and then use the nut runner to completely unscrew the nut.

(g) Withdraw the tube from the seal housing, remove the cover from the tube.

(h) Withdraw the tube from the outside of the vane through the seal housing. Remove the seal ring assembly from the barrel nut and the union nut from the tube.

(j) Unscrew the three attachment nuts and remove the seal housing and gasket.

(k) On engines to pre S.B.OL.593-72-8588-218 standard, when the same tube is to be re-installed, inspect the tube in accordance with the requirements of S.B.OL.593-72-A119.

R (l) If the tube is rejected unscrew the jet guard
R from the inner end of the tube and retain for
R assembly to replacement tube.

(2) Install tube.

<u>NOTE</u>: If seal housing and tube are new items, ensure that housing and tube are both to the same service bulletin standard, then trial assemble the housing over the tube to ensure that the housing slides easily over the mating part at

CR 34170/00EI

BEARING HOUSING COVER

SEAL HOUSING

BARREL NUT

VANE NO. 6

COVER

JET GUARD SB 72-48

SEAL RING ASSEMBLY

OIL FEED TUBE ASSEMBLY

HEAT SHIELD

GASKET

SEAL HOUSING

TURBINE EXHAUST DIFFUSER CASE

UNION NUT

SECTION THROUGH VANE NO. 6
SHOWING TUBE TO
S.B. OL.593-72-101 STANDARD
CORRECTLY POSITIONED

CMR 72 01 03 4 DAFO

LP Turbine Bearing Internal Oil Feed Tube.
Figure 404

R

the outside end of the tube.

(a) On engines to pre S.B.OL.593-72-8588-218 standard, ensure that the tube meets the requirements of S.B.OL.593-72-119.

R (b) If replacement tube is to be fitted apply lubricant A to the jet guard threads, then screw it into the inner end of the oil tube assembly and torque-tighten to 30 lbf in. (3,4 N.m).

R (c) Place the union nut, seal housing and gasket over the barrel nut end of the tube and slide them to the other end of the tube.

R (d) Apply lubricant B to each seal of the seal ring assembly.

R (e) With an outward sprung ring assembled first, assemble the four seal rings to the groove in the barrel nut with the remaining inward and' outward sprung rings in alternate sequence.

(i) Screw the four rings, in turn, along the nut thread and ease them into the nut groove.

(f) Apply lubricant B to cover the bolt, insert the bolt through the cover clamp bolt-hole and screw the nut onto the bolt. Do not tighten the nut.

R (g) Lubricate the barrel nut threads with lubricant A.

R (h) Insert the barrel nut end of the tube into the forward round hole through the outer case into No.6 vane and guide the tube through the vane and, at the the same time, locate the gasket and seal housing over the three bolts protruding through the outer case.

R (j) When the barrel nut protrudes through the inner end of the vane, position the cover over the end of the nut, and feed the nut through the cover into the seal housing.

R (k) Position the tube in the vane.

(i) Turn tube to align barrel nut with housing

and, with a tube to S.B.OL.593-72-101 or 593-72-8588-218 standard, turn so that the tube bend contacts the inner edge of the vane convex face.

NOTE: Tubes to S.B.OL.593-72-101 and 595-72-8588-218 standard are bent whereas tubes to pre S.B.OL.593-72-101 are straight and run centrally through the vane.

(l) Pull the cover clear of the barrel nut, then push the tube into the vane so that the nut enters the seal housing.

R (m) With lubricant A applied, screw the three nuts onto the outer case bolts and torque tighten
R to 100 lbf in. (11,5 N.m). Ensure the locking (run-down) torque is not less than 3.5 lbf in. (0,4 Nm.).

(n) Screw the barrel nut into the seal housing and, using the nut runner, lightly tighten.

(i) Assemble the nut runner to the barrel nut and insert the holder between the runner and the tube shoulder to engage with the flats on the tube.

(ii) Use the holder to maintain the tube in the set position within the vane and, with a suitable tommy bar to turn the runner lightly tighten the nut.

(p) Establish the tightening force to be applied that will result in a tightening torque of between 280 and 310 lbf in. (32 and 35 N.m) at the barrel nut. Position the spanner(s) and torque wrench on the torque adapter and checking fixture with the same angle and manner of application as to be used on the nut. Note the load applied on the torque wrench that gives the required torque-tightening.

(q) Retain the tube in position with the holder engaged with the flats at the inner end of the tube and with the spanners, to be used alternately as required, and torque wrench apply the predetermined torque load (Ref.para.(m)) required to tighten the nut to between 280 and 310 lbf in. (32 and 35 N.m).

R (r) Wire-lock the nut to one of the three holes in the inner lip of the seal housing. Position the locking wire to allow the cover to slide over the tube and abut the seal housing.

R (s) Insert locking wire through the locking wire hole in the seal housing rear bolt, of sufficient length, to wire-lock the two cover securing bolts at a later stage.

R (t) Slide the cover over the tube and into abutment with the seal housing and, with the clamp nut and bolt to the rear, align the attachment bolt-holes.

R (u) With lubricant B applied, secure the cover with two bolts torque-tightening to between 67 and 73 lbf in (7,6 and 8,2 N.m). Wire-lock the bolts to the rear bolt in the seal housing using the locking wire already attached.

R (v) Torque-tightening the clamp nut and bolt to between 67 and 73 lbf in. (7,6 and 8,2 N.m). Ensure the locking (run-down) torque is not less than 3,5 lbf in. (0,4 N.m).

R (w) Install rear external tube section as detailed in paragraph D.(2).

R (x) Install the jet pipe thermocouple harness and lead-out (Ref. 77-21-02, Removal/Installation).

R (y) Install the reheat injection system (Ref. 73-12-06, Removal/Installation).

R (z) Carry out procedure detailed in paragraph F.

F. Complete the Installation.

(1) With the oil tank full (Ref. 12-13-79, Servicing) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to that drained during removal procedure.

(2) Close engine bay doors (Ref.71-00-00, Servicing).

5. <u>Oil Pressure Indication Feed Tubes</u> (Ref. Fig. 405)

A. Prepare to Remove Tubes.

(1) Obtain access to the tubes detailed in paragraphs B

and C by opening No.2 and No.4 engine bay front doors. Open No.1 and No.3 engine bay lower front door to gain access to the tube detailed in paragraph C. Remove engines No.1 and No.3 to gain access to the tube detailed in paragraph B. Refer to 71-00-00, Servicing.

B. Oil Feed Tube (Intermediate Case to Tube Connection).

(1) Remove tube.

(a) Comply with the requirements of paragraph A.

(b) Position a container to catch oil drainage and unscrew the union nuts at each end of tube.

(c) Detach clamp assembly from support bracket and remove tube from engine.

(d) Measure and record the quantity of oil drained.

(2) Install tube.

(a) Apply lubricant A to union connections.

(b) Position tube on engine and screw on union nuts hand-tight.

(c) Attach and secure tube clamp assembly to support bracket with a flat washer and bolt torque-tightened to between 85 and 95 lbf in. (9,6 and 10,7 N.m) with lubricant B applied.

(d) Torque-tighten both union nuts to between 220 and 240 lbf in. (25 and 27 N.m). Wire-lock union nuts.

(e) Comply with the requirements of paragraph D.

C. Oil Feed Tube (Tube Connection to Pulse Probe Drive and Housing).

(1) Remove tube.

(a) On engines 2 and 4, remove standby hydraulic pump (Ref.29-21-71, Removal/Installation).

(b) Position a container to catch oil drainage and unscrew union nut at tube connection.

INTERMEDIATE CASE
A
B
C
D
HYDRAULIC PUMP
PULSE PROBE DRIVE AND HOUSING
GASKET
FLAT WASHER
CLIP NUT
FLAT WASHER
FLAT WASHER
CMR 72 01 03 4 DAMO

Oil Pressure Indication Feed Tubes
Figure 405

(c) Remove bolts securing tube flange to pulse probe drive and housing.

(d) Detach clamp assemblies from support brackets and remove tube from engine.

(e) Measure and record the quantity of oil drained.

(2) Install tube.

(a) Apply lubricant A to union connection and lubricant B to attachment bolts.

(b) Hold tube on engine with a gasket positioned between tube flange and pulse probe drive and housing and attach tube to housing with three bolts lightly tightened.

(c) Connect and screw on union nut hand-tight.

(d) Attach and secure tube clamp assembly (Ref. Fig. 404, detail B) to support bracket with a bolt, flat washer and nut torque-tightened to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(e) Attach and secure tube clamp assemblies (Ref. Fig.404, detail C) to support bracket with a bolt, flat washers and nut torque-tightened to between 67 and 73 lbf in (7,6 and 8,3 N.m).

(f) Torque-tighten the three tube flange attachment bolts to between 60 and 65 lbf in. (6,8 and 7,3 N.m) and the union nut to between 220 and 240 lbf in. (25 and 27 N.m). Wire-lock union nut.

(g) On engines 2 and 4, install standby hydraulic pump (Ref.29-21-71, Removal/Installation).

(h) Comply with the requirements of paragraph D.

D. Complete the Installation.

(1) With the oil tank full (Ref.12-13-79, Servicing) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to that drained during removal procedure.

(2) Install engines No.2 and No.4 as applicable and on completion of work close engine bay doors (Ref.

71-00-00, Servicing).

6. HP Turbine Bearing Oil Feed Tube

To be issued later.

TUBES - OIL SCAVENGE, BEARINGS TO PUMP- REMOVAL/INSTALLATION

1. General

Paragraphs 2 to 5 detail the removal/installation procedures for oil scavenge tubes from the LP compressor front bearing, the compressor thrust bearings, the HP turbine bearing and the LP turbine bearing respectively. The paragraphs are sub-divided to provide individual procedures for the tube sections.

Details of approved servicing and storage materials quoted in this chapter are given in 70-00-01.

R CAUTION: A DRY CYCLE CHECK OR IDLE LEAK CHECK MAY NOT CONFIRM
R THAT A JOINT IS LEAK FREE.

R Following disturbance to the oil tubes, it is necessary to
R carry out a ground run (Ref. 71-00-00, Adjustment/Test) and
R check for oil leakage.

2. LP Compressor Front Bearing Oil Scavenge Tubes (Ref.Fig.401)

A. Prepare to Remove Tubes by Sections (Ref. Para.B., C. and D.).

(1) Open engine bay front lower door (Ref.71-00-00, Servicing).

(2) Drain oil from left-hand gearbox, measure and record quantity drained (Ref.72-01-00, Servicing).

B. Scavenge Flange.

(1) Remove flange.

(a) Comply with paragraph A.

(b) Unscrew vent tube union nut from scavenge flange.

(c) Position a container to catch oil drainage and unscrew union nut securing scavenge flange to connecting tube.

(d) Remove eight bolts securing scavenge flange to anti-icing connector and remove flange, together with gasket (Ref. S.B. OL.593-72-35), from engine. Discard gasket.

(e) Measure and record the quantity of oil drained.

(2) Install flange.

CR 31486/00C

ANTI-ICING CONNECTOR
SCAVENGE FLANGE
GASKET
TUBE (SCAVENGE FLANGE TO TUBE CONNECTION)
VENT TUBE
A

SCAVENGE TUBE (TUBE CONNECTION TO OIL PUMP)
UNION CONNECTION
G
A B C D E F

CLIP NUT
B

THERMOCOUPLE ADAPTER
BOLT AND NUT
HE IGNITER LEAD CLAMP
C

FLAT WASHER
D

BOLT AND NUT
E

FLAT WASHER
DISTANCE PIECE
F

CMR 72 01 04 4 AAM0

LP Compressor Front Bearing
Oil Scavenge Tubes
Figure 401

(a) Apply lubricant A to union connections and lubricant B to attachment bolts.

(b) Position scavenge flange, together with new gasket (Ref. S.B. OL.593-72-35), on engine and secure with eight bolts torque-tightened to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(c) Connect scavenge tube union nut and torque-tighten to between 310 and 340 lbf in. (35 and 38 N.m).

(d) Connect vent tube union bolt and torque-tighten to between 220 and 240 lbf in. (25 and 27 N.m).

(e) Wire-lock the four centre bolts of the scavenge flange together and wire-lock union connections.

(f) Complete the installation (Ref.Para.E.).

C. Oil Scavenge Tube (Scavenge Flange to Tube Connection).

(1) Remove tube.

(a) Comply with paragraph A.

(b) Position a container to catch oil drainage and unscrew union nuts at each end of tube.

(c) Detach high energy ignition leads clamp from support bracket on tube thermocouple adapter.

(d) Detach tube clamp assembly from support brackets and remove tube from engine.

(e) Measure and record the quantity of oil drained.

(2) Install tube.

(a) Apply lubricant A to union connections and lubricant B to attachment bolts.

(b) Position tube on engine and screw on the two union nuts hand-tight.

(c) Attach and secure tube clamp assemblies to support brackets as shown. Torque-tighten attachment bolt on rearmost bracket to between 67 and 73 lbf in. (7,6 and 8,2 N.m) and pillar bolt on forward bracket to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(d) Torque-tighten union nuts to between 310 and 340 lbf in. (35 and 38 N.m). Wire-lock union nuts.

(e) If a new tube has been installed, transfer the high energy ignition cables support bracket from the removed tube to the new tube and secure with two bolts torque-tightened to between 60 and 65 lbf in. (6,8 and 7,3 N.m).

(f) Attach and secure high energy ignition leads to support bracket with a bolt and nut torque-tightened to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(g) Complete the installation (Ref.Para.E.).

D. Oil Scavenge Tube (Tube Connection to Oil Pump).

(1) Remove tube.

(a) Comply with paragraph A.

(b) Position a container to catch oil drainage, unscrew tube union nut and remove bolts securing tube flange to oil pump.

(c) Detach electrical lead clamp from bracket mounted on tube.

(d) Detach tube clamp assembly from support bracket and remove tube from engine.

(e) Measure and record the quantity of oil drained.

(2) Install tube.

(a) Apply lubricant B to attachment bolts and lubricant A to union connection.

(b) Hold tube on engine with a gasket placed between tube flange and oil pump. Attach tube to oil pump with five bolts lightly tightened.

(c) Connect and screw on union nut hand tight.

(d) Attach and secure tube clamp assembly to support bracket as shown. Torque-tighten nut to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(e) Torque-tighten bolts securing tube to oil pump to between 67 and 73 lbf in. (7,6 and

8,2 N.m).

(f) Torque-tighten union nut to between 310 and 340 lbf in. (35 and 38 N.m). Wire-lock union nut.

(g) If a new tube has been installed transfer the electrical lead support bracket from the removed tube and secure it to the new tube with two bolts and nuts torque-tightened to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(h) Attach and secure electrical lead clamp to bracket mounted on tube with a bolt and nut torque-tightened to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(j) Complete the installation (Ref.Para.E.).

E. Complete the Installation

(1) With the oil tank full (Ref.12-13-79) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to that drained during removal procedure.

(2) Close engine bay doors (Ref.71-00-00, Servicing).

3. LP and HP Compressor Thrust Bearings Oil Scavenge Tube (Ref. Fig. 402)

A. Prepare to Remove Tube

(1) Open engine bay front lower door (Ref.71-00-00, Servicing).

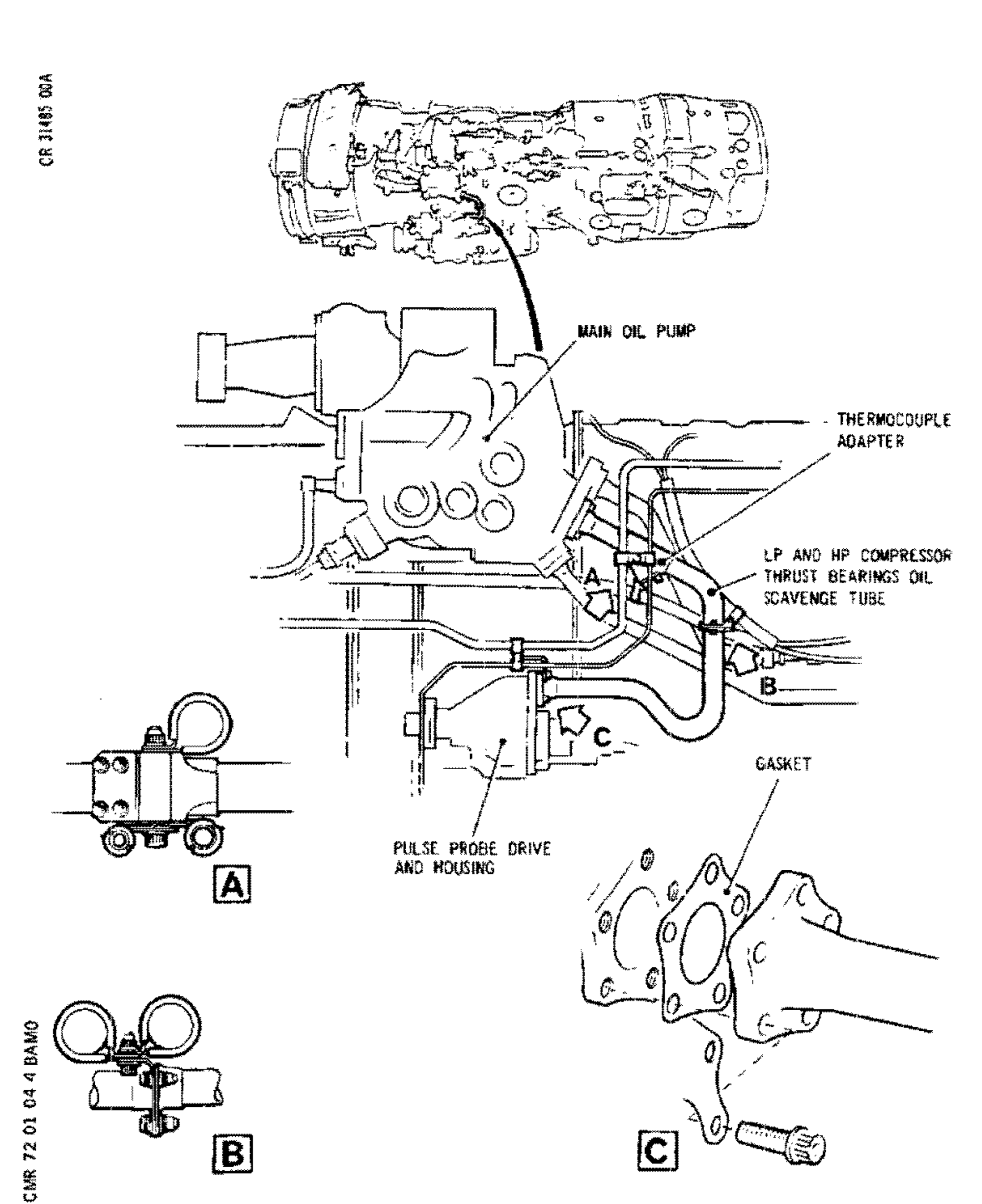
(2) Drain oil from left-hand gearbox and measure and record quantity drained (Ref.72-01-00, Servicing).

B. Remove Tube

(1) Detach electrical harness clamps from support bracket mounted on tube.

(2) Detach tube clamps and the electrical harness clamp from the thermocouple adapter on the tube.

(3) Position a container to catch oil drainage and remove bolts securing tube flanges to oil pump and pulse probe drive and housing. Remove tube from engine.



LP and HP Compressor Thrust Bearings
Oil Scavenge Tube
Figure 402

(4) Measure and record the quantity of oil drained.

C. Install Tube

(1) If a new tube is to be installed transfer the electrical harness support bracket from the removed tube to the new tube and secure with bolts and nuts torque-tightened to between 67 and 73 lbf in. (7,6 and 8,2 N.m) with lubricant B applied.

(2) Apply lubricant B to attachment bolts then hold tube on engine with a gasket positioned at both flanged connections.

(3) Attach tube flange to oil pump with five bolts lightly tightened.

(4) Attach tube flange and support bracket to pulse probe drive and housing with five bolts lightly tightened. Position the two longer bolts at the bracket location.

(5) Torque-tighten bolts at the two joint flanges to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(6) Attach and secure electrical harness to support bracket mounted on tube as shown. Torque-tighten nut to between 67 and 73 lbf in. (7.6 and 8,2 N.m).

(7) Attach and secure tube clamps and the electrical harness clamp to the thermocouple adapter on the tube as shown. Apply lubricant A and torque-tighten nut and bolt to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

D. Complete the Installation

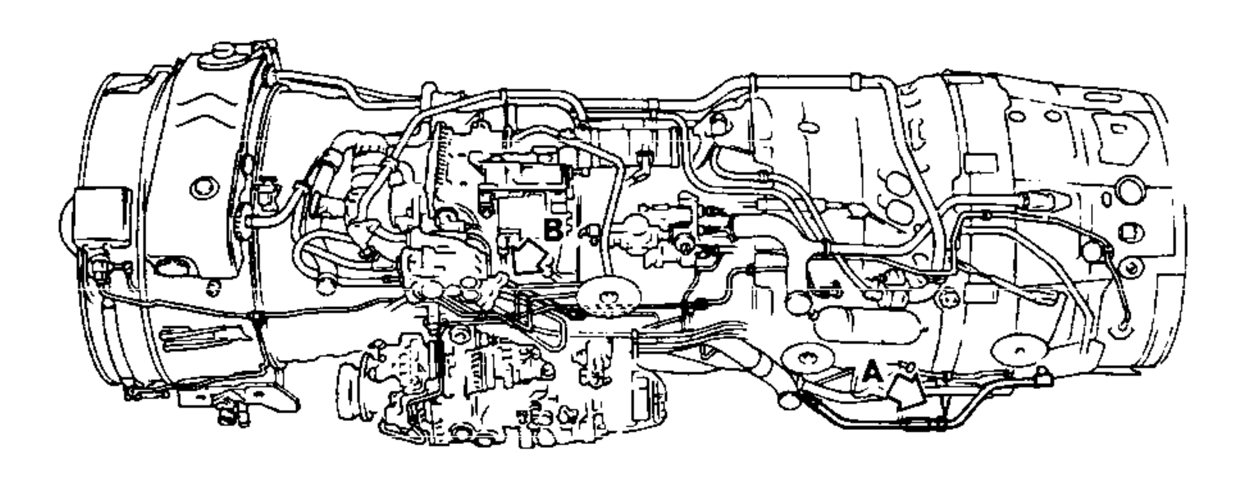
(1) With the oil tank full (Ref.12-13-79) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to that drained during removal procedure.

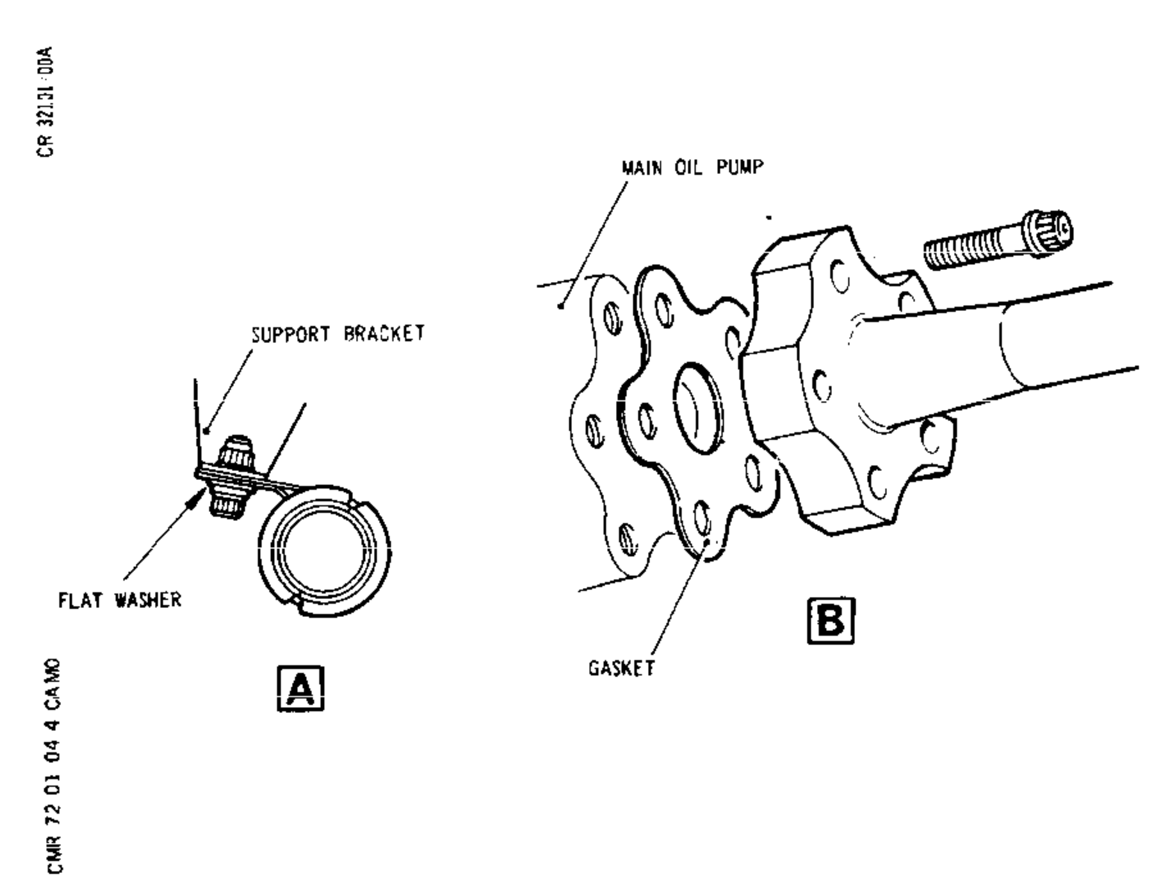
(2) On completion of work, close engine bay door (Ref. 71-00-00, Servicing).

4. <u>HP Turbine Bearing Oil Scavenge Tube</u> (Ref. Fig. 403)

A. General

The HP turbine bearing oil scavenge tube comprises





HP and LP Turbine Bearing
Oil Scavenge Tubes
Figure 403

of two tube sections, HP compressor delivery case to tube connection and tube connection to oil pump. The procedure for the tube section, tube connection to oil pump, is detailed in paragraph C.

B. Prepare to Remove Tube Section (Ref.Para.C.).

(1) Open engine bay front lower door (Ref.71-00-00, Servicing).

(2) Drain oil from left-hand gearbox and measure and record quantity drained (Ref.72-01-00, Servicing).

C. Oil Scavenge Tube (Tube Connection to Oil Pump)

(1) Remove tube.

(a) Comply with paragraph A.

(b) Position a container to catch oil drainage and unscrew union nut.

(c) Remove bolts securing tube flange to oil pump and remove tube from engine.

(d) Measure and record the quantity of oil drained.

(2) Install tube.

(a) Apply lubricant B to attachment bolts and lubricant A to union connection.

(b) Hold tube on engine with a gasket positioned between tube flange and oil pump, then attach tube to pump with five bolts lightly tightened.

(c) Connect and hand-tighten union nut.

(d) Torque-tighten flange attachment bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(e) Torque-tighten union nut to between 400 and 440 lbf in. (45 and 49 N.m). Wire-lock union nut.

(f) Complete the installation (Ref.Para.D.).

D. Complete the Installation

(1) With the oil tank full (Ref.12-13-79) and the overflow drain connection drain plug installed, add a quantity

of oil to the tank equivalent to that drained during removal procedure.

(2) On completion of work, close engine bay doors. (Ref.71-00-00, Servicing).

5. LP Turbine Bearing Oil Scavenge Tube

A. General

The LP turbine bearing oil scavenge tube comprises of three tube sections, front and rear tubes mounted on the outside of the engine and an internal tube contained within vane No.5 of the turbine exhaust diffuser. The procedures for the rear external tube are detailed in paragraph C. and for the internal tube in paragraph D.

The procedures for the internal tube section incorporate the requirements of S.B.OL.593-72-A119 (which includes S.B.OL.593-72-102 and S.B.OL.593-72-121) and details the requirements of pre and S.B.OL.593-72-101.

B. Tools and Equipment

Spanner	T3AA2442
Torque Adapter	S3S11345000
Holder	S3S11347000

C. Rear External Tube (Ref. Fig. 403).

(1) Remove tube.

(a) Open engine bay lower doors (Ref.71-00-00, Servicing).

(b) Drain oil from left-hand gearbox and measure and record quantity drained (Ref.72-01-00, Servicing).

(c) Position a container to catch oil drainage and unscrew the union nuts at each end of tube.

(d) Detach tube clamp assembly from support bracket and remove tube from engine.

(e) Measure and record the quantity of oil drained.

(2) Install tube.

(a) Apply lubricant B to union connection on exhaust diffuser and lubricant A to union connection at tube joint.

(b) Position tube on engine and screw on the two union connections hand-tight.

(c) Attach and secure tube clamp assembly to support bracket with a bolt, flat washer against clamp surface and a nut torque-tightened to between 67 and 73 lbf in. (7,6 and 8,2 N.m) with lubricant B applied.

(d) Torque-tighten union nuts at each end of tube to between 490 and 550 lbf in. (55 and 62 N.m). Wire-lock both union nuts.

(e) Complete the installation (Ref.para.E.).

D. Internal Tube (Ref. Fig.404 and 405)

(1) Remove tube.

(a) Open engine bay rear doors (Ref.71-00-00, Servicing).

(b) Remove the reheat injection system (Ref.73-12-06, Removal/Installation).

(c) Remove the jet pipe thermocouple harness and lead-out (Ref.77-21-02, Removal/Installation).

(d) Remove rear external tube section as detailed in paragraph C.(1).

(e) Use the holder and spanner to release and unscrew the rear cover sump pipe union nut located inside the rear of the inner case.

(f) Withdraw the tube assembly from the outside of the vane through the seal housing and remove the union nut from the tube.

(g) Unscrew the three attachment nuts and remove the seal housing and gasket.

(h) On engines to pre S.B.OL.593-72-8588-218 standard when the same tube is to be re-installed, inspect in accordance with the requirements of S.B.OL.593-72-A119.

CR 34171/00B

BEARING HOUSING COVER
REAR COVER SUMP PIPE
FORWARD
VANE NO. 5
GASKET
SEAL HOUSING
TURBINE EXHAUST DIFFUSER CASE
OIL SCAVENGE TUBE ASSEMBLY
HEAT SHIELD
UNION NUT

CMR 72 01 04 4 DAFO

LP Turbine Bearing Internal
Oil Scavenge Tube
Figure 404

(2) Install tube.

NOTE: If seal housing and tube are new items, ensure that housing and tube are both to the same service bulletin standard, then trial assemble the housing over the tube to ensure that the housing slides easily over the mating part at the outside end of the tube.

(a) On engines to pre S.B.OL.593-72-8588-218 standard, ensure that the tube meets the requirements of S.B.OL.593-72-A119.

(b) Place the union nut, seal housing and gasket over the threaded end of the tube and slide them to the other end of the tube.

(c) Apply lubricant A to the tube threads.

(d) Insert the tube into the rear hole in the outer case in line with No.5 vane and if tube ends are marked 'REAR' or have a machined flat, ensure that these markings remain facing rearward when guiding the tube through the vane.

NOTE: Dependent or Service Bulletin standard, tube ends will be either unmarked or marked 'REAR' at both ends or 'REAR' at the inner end with a machined flat at the outer end (Ref. Fig. 405).

(e) Engage the tube on the ferrule of the rear cover sump pipe and at the same time locate the gasket and the seal housing at the other end of the tube over the three bolts protruding through the outer case.

(f) Screw the sump pipe union nut onto the tube but do not tighten at this stage.

R (g) With lubricant A applied, screw the three nuts onto the outer case bolts and torque-tighten to
R 100 lbf in. (11,5 N.m). Ensure the locking (run-down) torque is not less than 3.5 lbf in. (0,4 N.m).

(h) Establish the tightening force to be applied that will result in a tightening torque of between 310 and 340 lbf in. (35 and 38 N.m) at the nut. Position the spanner and torque wrench on the torque adapter and checking fixture with the same angle and manner of application as to be used on

wrench that gives the required nut torque-tightening.

(j) On engines to S.B.OL.593-72-101, 72-8440-194, 72-8588-218 or 72-8790-306 standard, position the tube in the vane (Ref. Fig. 405).

<u>CAUTION:</u> POSITION TUBE STRICTLY AS SHOWN WITH 'REAR' MARKINGS OR MACHINED FLAT FACING REARWARD. HEAVY FRETTING COULD OCCUR ON TUBES THAT ARE INCORRECTLY POSITIONED.

(i) Position the flats at the inner end of the tube so that they run from front to rear of the exhaust diffuser case with the curve of the tube towards the convex face of the vane, see Section BB.
The rear markings on the tube should face rearwards. If 'REAR' or machined flat is not marked on the tube the tube will have to be accurately orientated before the tube is offered up into the vane.
Extreme care should then be taken to avoid rotating the tube in the vane.

<u>NOTE:</u> Tubes to S.B.OL.593-72-101, 72-8440-194, 72-8588-218 and 72-8790-306 standard are bent whereas tubes to pre S.B.OL.593-72-101 are straight and run centrally through the vane.

(k) Retain the tube in position with the holder engaged with the flats at the inner end of the tube and, with the spanner and torque wrench, apply the predetermined torque load (Ref.para. (g)) required to tighten the nut to between 310 and 340 lbf in. (35 and 38 N.m).

(1) Wire-lock the union nut to the tube.

(m) Install rear external tube section as detailed in paragraph C.(2).

(n) Install the jet pipe thermocouple harness and lead-out (Ref.77-21-02, Removal/Installation).

(p) Install the reheat injection system (Ref.73-12-06, Removal/Installation).

CR 35075/00C

SECTION A - A

SCAVENGE TUBE

SECTION THROUGH
VANE No 5
(LOOKING FORWARD)

MACHINED FLAT
S.B. 72-8790-306

'REAR' MARKING
ALTERNATIVE POSITIONS

REAR

SECTION B-B

SECTION C-C

Scavenge Tube Positioned in Vane
Figure 405

R

(q) Carry out procedure detailed in paragraph E.

E. Complete the Installation

(1) With the oil tank full (Ref.12-13-79, Servicing) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to that drained during removal procedure.

(2) Close engine bay rear doors (Ref.71-00-00, Servicing).

Printed in England

PRESSURIZATION AND COOLING AIR SYSTEM - DESCRIPTION AND OPERATION

1. General

The engine operates under high temperature conditions and is cooled internally by air taken from the compressor. The labyrinth seals enclosing the bearing chambers are pressurized by air taken from the compressor to ensure that the oil is contained within the chambers and is isolated from the hot gases. Tubes are used to convey some air externally and are described in 75-00-00. The connections for the internal flow paths are shown. (Ref. Fig. 001).

Three sources are used for the air supply, LP compressor delivery, fifth stage HP compressor air and HP compressor delivery air.

A connection on the aircraft primary nozzle supply tube provides air for the reheat igniter.

Some of the cooling and pressurization air is exhausted through external hot or cold vent tubes.

2. LP Compressor Delivery Air Distribution (Ref. Fig.002 and 003)

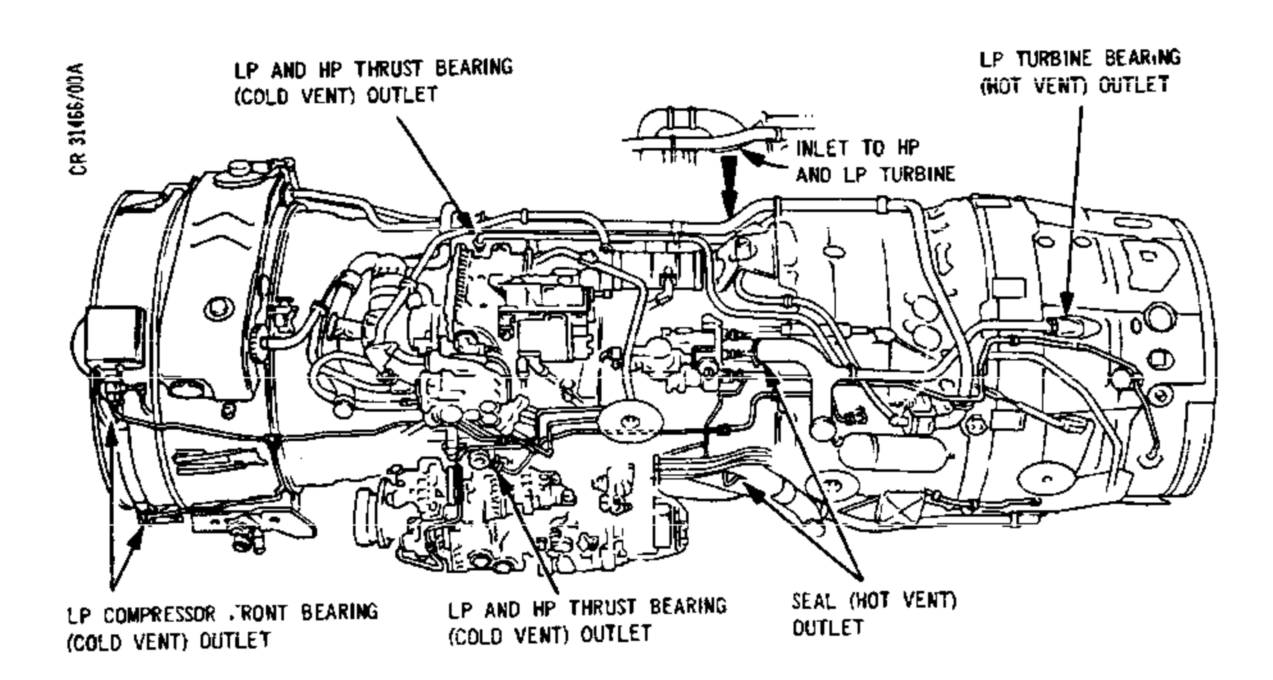
A. Air Utilization.

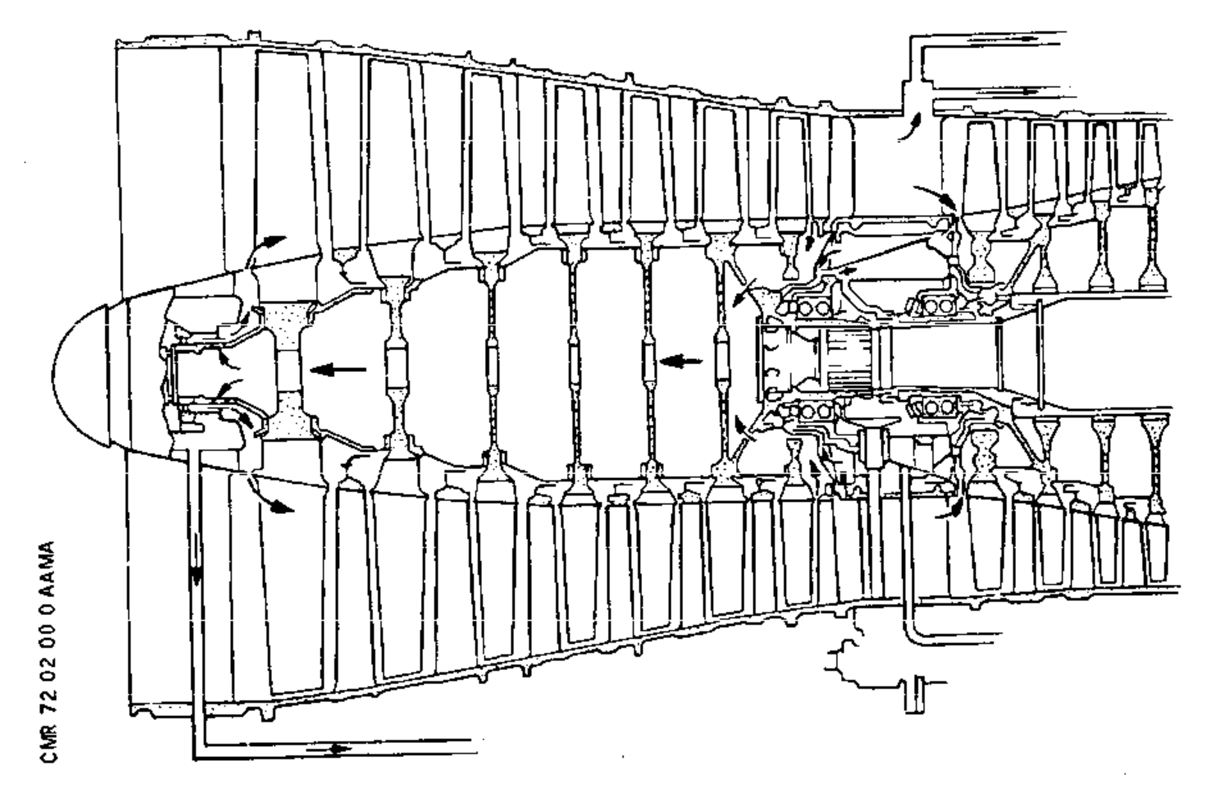
Air is taken from this source and used to pressurize the LP compressor front bearing, the LP and HP compressor thrust bearings and the HP and LP turbine bearings.

The bearing chambers, enclosed by labyrinth seals, are surrounded by a vent chamber also sealed by labyrinth seals. Pressurizing air is applied to the vent chamber seal and passes into the vent chamber. The pressurization ensures that bearing lubricating oil is contained in the bearing chamber.

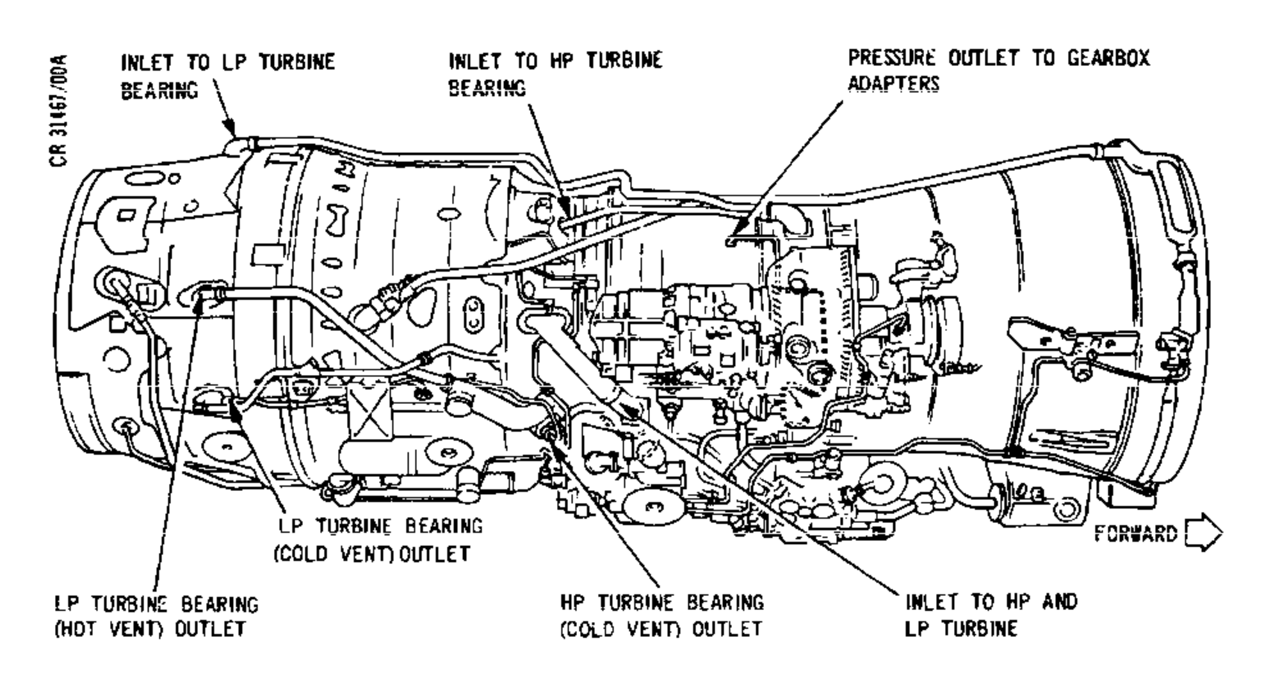
B. LP Compressor Front Bearing and LP and HP Thrust Bearings.

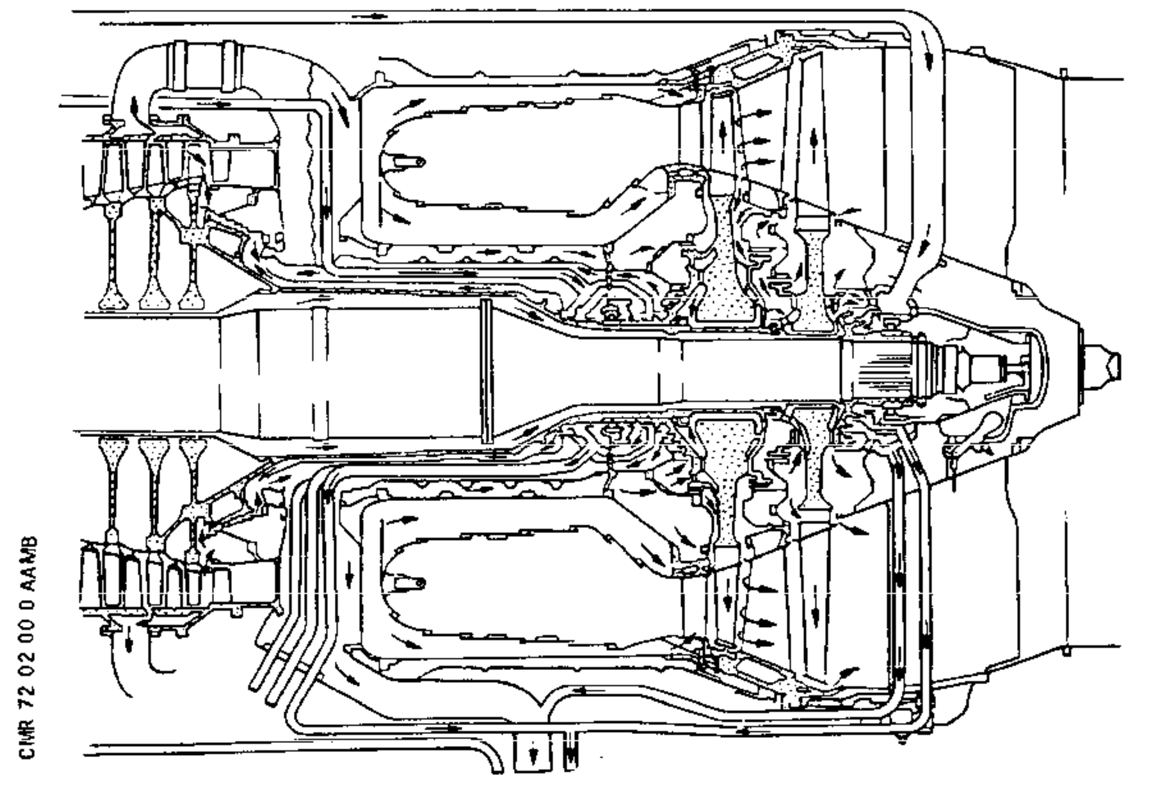
Air flow, bled internally from the intermediate case region, pressurizes the thrust bearing housing seals and directs some air forward through the shaft centre to pressurize the LP front bearing seals. The air from the vent chamber is directed through tubes in inlet guide vanes No.3 and No.4 to the cold vent outlet connections on the air intake case. Any air passing into the bearing housings is evacuated with bearing scavenge oil and vented via the oil tank vent system.





- Cooling, Pressurization and Venting Connections
(Sheet 1 of 2)
Figure 001





- Cooling, Pressurization and Venting Connections
(Sheet 2 of 2)
Figure 001

CR 31949 00A

LP COMPRESSOR DELIVERY AIR

COLD VENT AIR

BEARING HOUSING SUPPORT AND COVER

LP COMPRESSOR FRONT BEARING

COLD VENT

FRONT AIR BAFFLES

HP ROTOR SHAFT FRONT

LP ROTOR SHAFT REAR

LP COMPRESSOR DRIVE SHAFT FRONT

CMR 72 02 00 0 BAMO

LP ROTOR SHAFT FRONT

LP COMPRESSOR THRUST BEARING

HP COMPRESSOR THRUST BEARING

REAR AIR BAFFLES

- LP Compressor Delivery Air Pressurization Distribution
Figure 002

Air passing the outer seals rejoins the engine air flow.

C. HP Turbine Bearing.

Air to pressurize the HP turbine bearing enters through No.3 vane of the HP compressor diffuser case and is delivered via an internal tube to a pressurizing chamber formed by the HP turbine bearing housing and cover unit. Air passes the back up seals and enters the vent chamber and pressurizes the primary seals of the bearing chamber. Air is directed from the region of the bearing vent chamber to the cold vent outlet connection by an internal tube. Any oil seepage is prevented from accumulating in the bottom of the vent chamber by an oil drain connection that connects into the vent tube below the level of the bearing.

Any air that passes into the bearing chamber is evacuated with the oil and vents via tank vent system.

D. LP Turbine Bearing.

Air to pressurize the LP turbine bearing is ducted through a tube in No.2 vane of the turbine exhaust diffuser. The air flows forward into an annulus formed by the two intermediate labyrinths of the LP turbine bearing housing via holes in the inner annulus and is contained by the LP hub. Air flows out of the chamber through the chamber outer and inner labyrinths. Through the outer labyrinth air escapes to the hot vent through tubes in No.4 and 7 vanes. The inward air flows through the inner labyrinth and through a tube in No.5 vane of the exhaust diffuser to vent to atmosphere with air from the HP turbine bearing.

3. Fifth Stage HP Compressor Air Distribution (Ref. Fig. 003)

A. Air Utilization

Air from this source is used to cool the HP and LP turbines, HP and LP turbine rotor disks and blades.

B. HP and LP Turbines and Rotor Disks.

Air to cool the HP and LP turbines enters through No.1 and No.4 vanes of the HP compressor diffuser case into an annulus formed by the HP turbine bearing support and outer duct. From the annulus the flow divides allowing a minor flow to continue outward along the front face of the turbine disk from the outer labyrinth to exhaust into the main gas stream.

CR 31468/00A

CMR 72 02 00 0 CAMA

HP TURBINE ROTOR BLADES

HP TURBINE DISK

HP TURBINE NOZZLE VANE

LP TURBINE ROTOR BLADE

HP COMPRESSOR DELIVERY

FIFTH STAGE HP COMPRESSOR

LP COMPRESSOR DELIVERY

COLD VENT

HOT VENT

HP TURBINE NOZZLE VANE

LP TURBINE NOZZLE VANE

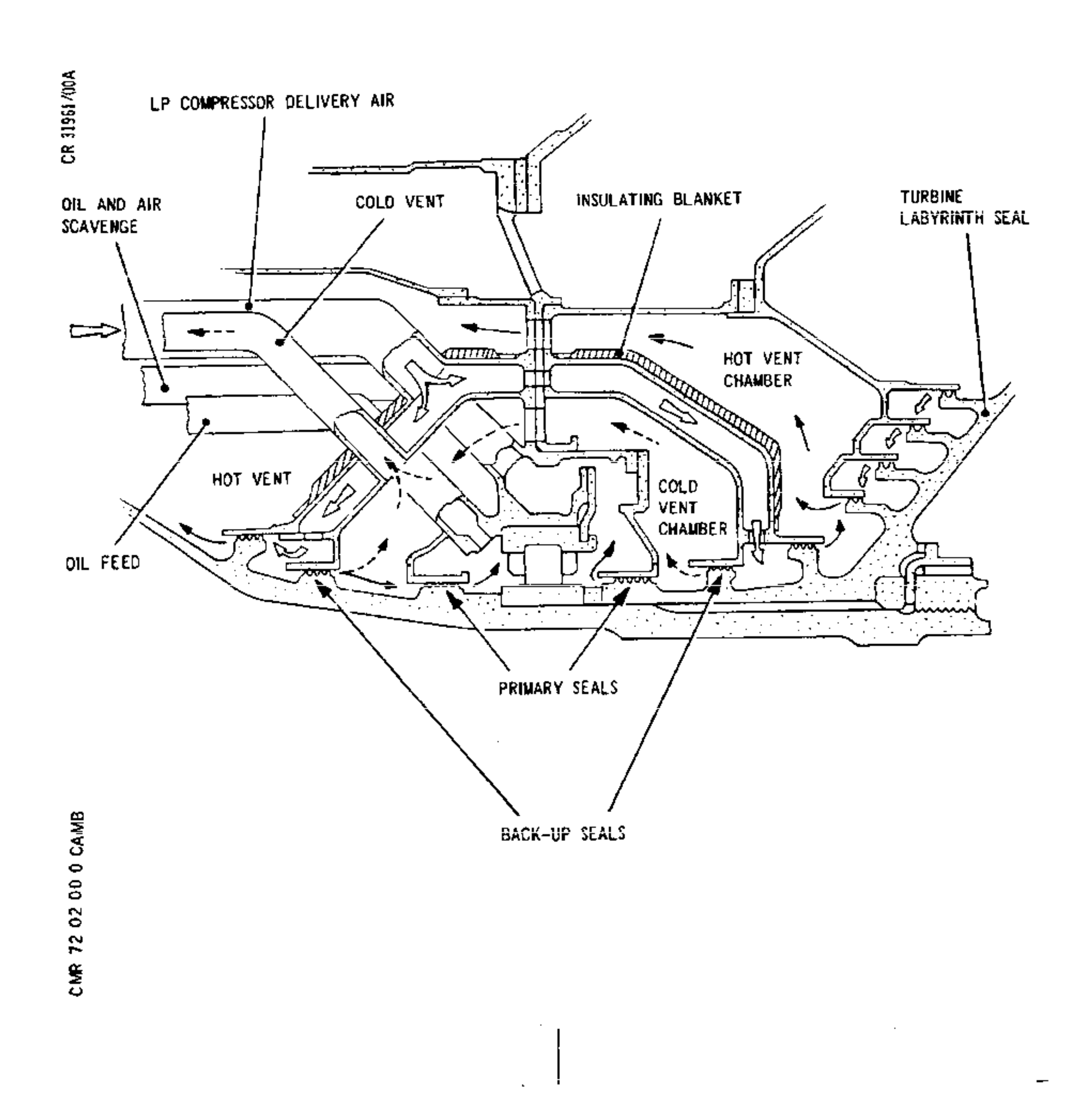
HP TURBINE BEARING

HP TURBINE DISK

LP TURBINE DISK

LP TURBINE BEARING

\- HP and LP Turbine Cooling (Sheet 1 of 2)
Figure 003



\- HP and LP Turbine Cooling (Sheet 2 of 2)
Figure 003

The major flow continues between the HP turbine hub and turbine disk centre to provide inter disk cooling. A series of holes in the HP turbine rear labyrinth allows the bulk of the air to flow in a rearward direction into a plenum chamber formed by the HP turbine rear labyrinth and LP turbine front labyrinth.

A part of the cooling air, having passed through the first slope of the LP turbine disk front inner labyrinth then passes through holes in the LP turbine disk front labyrinth, continues along the front face of the turbine disk and blade roots to exhaust into the gas flow. The remaining air flows through the centre of the LP turbine disk to cool the rear face and is then exhausted into the main gas stream.

C. HP Turbine Rotor Blades.

Nozzles in the HP turbine stator support cone direct cooling air to flow into each blade root and thence by holes, running through the entire length of each blade, cooling the rotor blade then exhausting into main stream at the tip.

D. LP Turbine Rotor Blades.

Similarly LP blade cooling air is directed into the blade roots by nozzles in the LP diaphragm. This air passing through holes in the blade profile and exhausting at blade tip into the main gas stream.

4. <u>HP Compressor Delivery Air Distribution</u> (Ref. Fig. 003)

A. Air Utilization.

Air from this source is used to cool the combustion chamber and HP and LP turbine nozzle vanes.

B. Combustion Chamber

Air flow in annular space between case and chamber provides a cooling layer between surfaces.

C. HP and LP Turbine Nozzle Vanes.

The turbine nozzle vanes are hollow and enclose centrally located integral air distribution inserts. Holes in the front of each insert discharge cooling air flow over the inner surface of the vane leading edge. The air flow passes over the vane inner surfaces and is exhausted into the main gas stream towards the trailing edge.

ENGINE TURNING

1. General

CAUTION: DO NOT TURN HP ROTOR ASSEMBLY UNLESS LUBRICATION HAS BEEN MADE EFFECTIVE BY ENGINE RUN. LABYRINTH RUB AND EXCESSIVE RESISTANCE TO ROTATION OCCURS WHEN BEARINGS HAVE NO OIL SQUEEZE FILM.

Provision is made for turning the HP and LP rotating assemblies using hand operated equipment. The HP assembly is turned through a drive in the right-hand gearbox, while the LP assembly is turned through a drive in the pulse probe drive and housing using the equipment installed as detailed in paragraph 3.

Two alternatives are listed, the adapter assembly allows rotation of the LP and HP rotors, whilst the adaptor and immobiliser assembly allows rotation and locking of the LP and HP rotors when carrying out the in-situ blade blending operation (Ref.72-31-00 and 72-33-00 Approved Repairs).

The lubricant quoted in these procedures is stated in 70-00-01, Servicing and Storage Material.

2. Tools and Equipment

	Adapter assembly	PE.20785
	Universal joint	PE.22056
	Preset torque wrench, for HP rotor	S3S12619000
	Preset torque wrench, for LP rotor	S3S12620000
	Torque adapter	T2.EP1594
R	Extension bar	T2.EC3312
	Adapter and immobiliser	S3S20255000

3. General Hand Turning Equipment - Installation/Removal

A. Install LP Turning Equipment (Ref.Fig.201, Detail A).

(1) Open the engine bay front lower door (Ref.71-00-00, Servicing).

(2) Remove the bolts securing cover to the pulse probe drive and housing flange, withdraw cover.

(3) Assemble the universal joint and the adapter to the cover flange.

(a) Engage universal joint drive with drive in the pulse probe drive and housing.

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A
B
EXTENSION BAR
ADAPTER ASSEMBLY (TOOL PE20785)
ADAPTER
UNIVERSAL JOINT
WARNING
LOCKING THUMBNUT
ADAPTER AND IMMOBILISER ASSEMBLY (TOOL S3S 20255000)
UNIVERSAL JOINT
TORQUE ADAPTER
ADAPTER
WARNING
TORQUE WRENCH

A
PULSE PROBE AND HOUSING
LP SHAFT TURNING POINT

B
RIGHT HAND GEARBOX
HP SHAFT TURNING POINT

General Hand Turning Equipment -
LP and HP Rotating Assemblies
Figure 201

(b) Position adapter on cover flange and, with assembly pin and universal joint engaged, press adapter to abut the cover flange.

(c) Secure the assembly with three equally spaced bolts torque-tightened to between 85 and 95 lbf in. (9,6 and 10,7 N.m) with lubricant A applied.

(4) Engage the extension bar square drive in the universal joint and assemble the torque adapter to the extension bar.

(5) Pre-set a torque wrench to between 150 and 180 lbf in. (16,9 and 20,3 N.m) and assemble to the torque adapter.

(6) Apply a gradual force at the torque wrench to turn the LP rotating assembly.

NOTE: The torque wrench is pre-set to prevent excessive loading should a sudden force be applied.

R (7) If the adapter and immobiliser is being used, hand-
R tighten the thumbnut to lock the LP rotor in the
R required position.

B. Install HP Turning Equipment (Ref.Fig.201, Detail B).

(1) If not previously carried out, open the engine bay front lower door (Ref.71-00-00, Servicing).

(2) Remove bolts and washers securing blank cover to engine right-hand gearbox cover flange. Withdraw cover.

(3) Assemble the universal joint and the adapter to the cover flange.

(a) Engage universal joint drive with drive in the right-hand gearbox.

(b) Position adapter on cover flange and, with assembly pin and universal joint engaged, press adapter to abut the cover flange.

(c) Secure the assembly with three equally spaced bolts torque-tightened to between 90 and 100 lbf in. (10,2 and 11,3 N.m) with lubricant A applied.

(4) Engage the extension bar square drive in the universal joint and assemble the torque adapter to the extension bar.

(5) Pre-set a torque wrench to between 360 and 400 lbf in. (40 and 45 N.m) and assemble to the torque adapter.

(6) Apply a gradual force at the torque wrench to turn the HP rotating assembly.

NOTE: The torque wrench is pre-set to prevent excessive loading should a sudden force be applied.

R (7) If the adapter and immobiliser is being used, hand-
R tighten the thumbnut to lock the HP rotor in the
R required position.

C. Remove LP Turning Equipment.

(1) Remove the torque wrench and torque adapter and withdraw extension bar.

R NOTE: If the adapter and immobiliser is being used,
R the thumbnut must be loosened before the
R extension bar can be withdrawn.

(2) Remove the bolts securing the adapter to the flange, remove the adapter and withdraw the universal joint.

CAUTION: FAILURE TO CORRECTLY RE-ASSEMBLE THE COVER, INCLUDING THE USE OF A NEW GASKET, WILL LEAD TO RAPID LOSS OF ENGINE OIL CONTENTS DURING FLIGHT.

(3) Ensure that the cover and new gasket are to the same Service Bulletin standard (Ref. S.B.OL.593-72-41), then assemble gasket and cover to the pulse probe drive and housing flange and secure with seven bolts torque-tightened to between 85 and 95 lbf in. (9,6 and 10,8 N.m) with lubricant A applied.

(4) Close engine bay front lower door (Ref.71-00-00, Servicing) on completion of work.

D. Remove HP Turning Equipment.

(1) Remove the torque wrench, withdraw the torque adapter and extension bar.

R NOTE: If the adapter and immobiliser is being used,
R the thumbnut must be loosened before the
R extension bar can be withdrawn.

(2) Remove the bolts securing the adapter to the gearbox cover flange, remove the adapter and withdraw the universal joint.

CAUTION: FAILURE TO CORRECTLY RE-ASSEMBLE THE COVER, INCLUDING THE USE OF A NEW GASKET, WILL LEAD TO RAPID LOSS OF ENGINE OIL CONTENTS DURING FLIGHT.

(3) Ensure that the blank cover and new gasket are to the same Service Bulletin standard (ref. S.B.OL.593-72-41), then assemble gasket and blank cover to gearbox cover flange and secure with seven bolts and washers torque-tightened to between 90 and 100 lbf in. (10,2 and 11,3 N.m) with lubricant A applied.

(4) Close engine bay front lower door (Ref.71-00-00, Servicing) on completion of work.

ENGINE INTERNAL EXAMINATION PREPARATION AND USE OF OPTICAL INSPECTION PROBE EQUIPMENT

1. General

Optical examination of compressor blades, turbine blades and combustion chamber is effected by use of illuminating optical probes of various sizes inserted into an engine through ports in engine casings. To give full examination coverage, the engine is turned during the examination (Ref.72-09-01).

Two types of optical inspection probes are used for internal examinations.

A. Projected light probes have a cold light output provided by a light source box and directed to the probe by a light transmitting cable. A power supply of 2A at 110V a.c. or 240V a.c. incorporating an earth connection is required for the light source box.

B. Distal light probes connect to a transformer and provide a hot light output from a quartz iodine bulb housed at the end of the probe. A power supply of 2A at 110V a.c. incorporating an earth connection is required for the transformer.

R B C. Read the following information regarding the use of bore-
R B scope equipment. This outlines how these may affect safety
R B and their classification relative to our Procedures. The
R B precautions listed <u>must</u> be complied with.

R B (1) Background and Description

R B Borescope inspections of internal engine components
R B are frequently carried out. These inspections, when
R B conducted with equipment utilising a light source box,
R B now require additional precautions to be taken to
R B eliminate risk of hazard when used in an environment
R B potentially containing combustible gases.

R B Engines installed or near an aircraft, inside or
R B outside a hangar, fall within the compass of this
R B environment. Uninstalled engines in workshops may
R B also be in a hazardous environment.

CR 31594/00C

COVER RETAINING SCREW
LIGHT SOURCE BOX
PROJECTED LIGHT PROBE
VOLTAGE SELECTOR SWITCH
LIGHT TRANSMITTING CABLE
QUARTZ IODINE BULB
ON/OFF SWITCH
COVER RETAINING SCREW
BRIGHTNESS SELECTOR
POWER SUPPLY PLUG
ON/OFF SWITCH
TRANSFORMER
DISTAL LIGHT PROB
BRIGHTNESS SELECTOR
POWER SUPPLY PLUG

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Optical Inspection Probe Equipment
Figure 201

R

These environments are termed "Zone 2" areas but dedicated Zone 2 certification for equipment is not granted by the Regulatory Authority and it is deemed "UNCERTIFIED EQUIPMENT".

A borescope kit comprises of several pieces of equipment but it is <u>only</u> the high intensity light source box which is of concern. Existing boxes (Uncertified Equipment) display a warning notice stating it must not be used in the presence of combustible gases.

Conditions of use of such equipment in a Zone 2 area in strict accordance with procedures (i.e. using gas monitors, etc.) would impose a considerable maintenance/operational burden.

An acceptable relaxation of this situation has been agreed following consultation/borescope demonstration with the Fire Protection Department; although relaxed, adequate safety standards and legal aspects are maintained provided the following precautions are adhered to.

(2) <u>Engines, Installed or near an aircraft</u>

(a) Check aircraft fuel log to ensure it has not uplifted a wide cut fuel (Jet B) during the previous 20 hours of operation.

(b) Aircraft must not be transferring fuel.

(c) Working inside aircraft fuel tanks must not be in progress.

(d) Flammable Liquids with a flash point below 90°F (32°C) must not be used within the Remotely High Risk area - as defined in Section 5.2, EDP-P-FIRE 4.

(e) Spraying or use of Petroleum Based Adhesives must not be permitted.

(f) Liquid Petroleum Gases must not be used within the Remotely High Risk area.

R B (g) If highly flammable liquids are present and
R B "Uncertified Equipment" needs to be used or if
R B any of the above conditions cannot be met, then
R B Section 5.3 of EDP-P-FIRE 4 must be vigilantly
R B followed.

R B (h) Where applicable, Bonding must take place.

R B (3) Engines in Workshops

R B (a) Conditions (2)(d), (2)(e), (2)(f) and (2)(g)
R B apply.

2. Prepare Probe Equipment (Ref.Fig.201)

A. Prepare and Test the Projected Light Probe Equipment.

(1) Retain the protective sleeve on the probe in position both during use and storage.

(2) Ensure cable contacts are clean and connect the cable to the light source box socket and probe.

(3) Check that the light source box is switched off. Set brightness control to minimum.

(4) Check light source box voltage selector switch.

(a) Release knurled screw at top of cover and remove cover retaining slotted screws. Lift up cover.

(b) Select either 110V or 240V as required.

(c) Secure cover with knurled screw and slotted screws.

(5) Connect light source box lead to power supply.

(6) Test the equipment light control.

CAUTION: DO NOT MOVE LIGHT SOURCE BOX WHILE SWITCHED ON OR WITHIN 30 SECONDS OF SWITCHING OFF. BULB FILAMENT IS NOT SHOCK RESISTANT WHEN HOT.

(a) Switch on power supply.

(b) Adjust brightness control and check response at probe.

(c) Return control to minimum setting and switch off light source box.

(d) In the event of hot light failure or inadequate brightness move stand-by lamp selector switch to alternative position and repeat test procedure.

B. Prepare and Test the Distal Light Probe Equipment.

<u>WARNING:</u> QUARTZ IODINE BULBS MUST NOT BE HANDLED IN SERVICE. HANDLING OF BULB WILL CAUSE SURFACE CONTAMINATION WHICH MAY CAUSE BULB TO SHATTER.

(1) Ensure contacts are clean and connect the probe to the transformer.

(2) Check that the transformer is switched off and set brightness control to minimum.

(3) Connect the transformer lead to the power supply.

(4) Test the equipment light control.

(a) Switch on power supply.

(b) Adjust brightness control and check response.

(c) Return control to minimum setting and then switch off transformer.

C. Optical Inspection Probe Lenses.

(1) Clean lightly contaminated objective lense or eye-piece as detailed in paragraph (2) or if heavily contaminated as detailed in paragraph (3).

(2) Wipe lenses with a clean, dry lint-free cloth or paper tissue and remove contamination.

(3) If lenses are heavily contaminated, clean with an alcohol solution.

(a) Obtain an alcohol solution (30 per cent by volume of ethyl alcohol or ethyl + methyl alcohol (industrial methylated spirit) with purified or distilled water).

(b) Apply alcohol solution with a clean, lint-free cloth or paper tissue, remove contamination from lenses and wipe dry.

(c) Use a clean, dry cloth or tissue and lightly polish lenses.

3. <u>Dismantle Equipment</u>

<u>WARNING:</u> THE CONNECTOR ON THE LIGHT TRANSMITTER CABLE (LIGHT GUIDE) AT THE LIGHT SOURCE END BECOMES VERY HOT DURING OPERATION. EXERCISE EXTREME CARE WHEN DISCONNECTING CABLE FROM LIGHT SOURCE. SEVERE BURNS MAY OTHERWISE RESULT.

A. Dismantle Projected Light Probe Equipment.

(1) Disconnect light source box lead from power supply.

(2) Disconnect light transmitting cable from probe and light source box.

(3) Place probes and light transmitting cable in appropriate storage container.

B. Dismantle Distal Light Probe Equipment.

(1) Disconnect transformer lead from power supply.

(2) Disconnect distal probe from transformer.

(3) Place distal probe into appropriate container.

ENGINE INTERNAL EXAMINATION - USE OF PHOTOGRAPHIC EQUIPMENT

1. General

To obtain permanent records of engine internal damage, photographic equipment is used in conjunction with internal inspection procedures using the optical inspection probes (Ref. 72-09-03).

Functional details of camera and film loading and unloading procedures are contained in the camera manufacturers information provided with the camera.

2. Tools and Equipment

R Adapter PE.15957

Camera assembly comprising:

- Case PE.15955
- Camera body PE.15953
- Screen (clear) PE.15954
- Lens PE.15956
- Viewfinder PE.15958
- Cable release PE.15979

Tripod stand PE.15960

Photographic film ... ... H.P.4 (Black and white) (or ASA. 408-650. DIN.27.20 equivalent).

3. Preparation of Photographic Equipment (Ref. Fig. 201)

A. Prepare Camera.

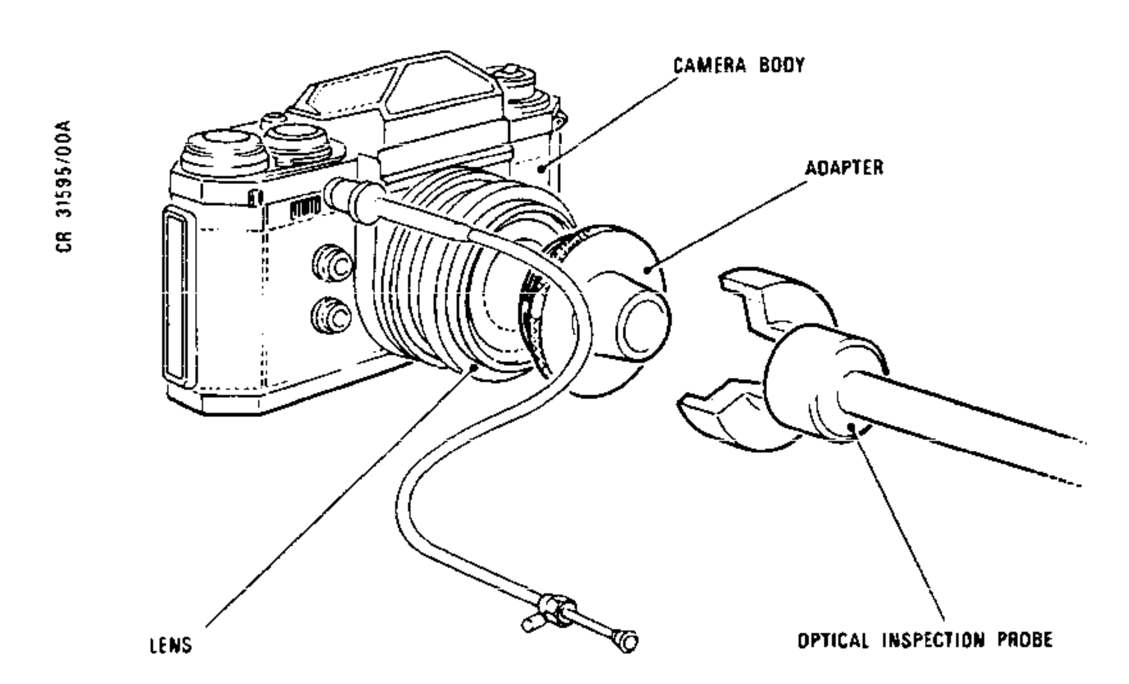
(1) Remove camera from case and check that all attachments are securely assembled to the body.

(2) Assemble adapter to camera by screwing adapter into camera lens filter thread and lightly tighten by hand.

(3) Load camera with film.

(4) Set camera controls as follows:

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Camera and Adapter
Figure 201

(a) Set aperture to max. (f2.8).

(b) Set aperture to 'M' (manual).

(c) Set focussing distance to 3.5 feet.

(d) Wind adhesive tape around the body of the lens, to lock the adjustments together and prevent accidental movement.

(e) Set shutter speed control to obtain the following exposure times:

HP compressor blades	...	1 second
LP compressor blades	...	2 seconds
Turbine blades ...	...	2 seconds
Combustion chamber	...	2 to 3 seconds

(5) Secure camera to tripod stand.

(6) Position tripod near area of operation on a firm flat surface.

B. Connect Camera to Intrascope Probe.

(1) Hold probe in position throughout photographic procedure.

(2) Remove eye-shield from probe.

(3) Position camera to effect alignment of adapter with probe. Adjust pan and tilt head to ensure that the adapter axis is exactly in line with the intrascope axis.

(4) Secure probe to adapter with adhesive tape.

(5) Through camera viewfinder, check that area to be photographed is in view, if necessary adjust camera and/or probe.

(6) Record film frame numbers and identify each frame with the area photographed.

(7) Set probe illumination light source to maximum setting.

(8) Ensure that there is no movement of engine or camera and operate camera shutter release.

(9) Take second photograph of damage area with one and

a half to twice the specified exposure time to allow for variations in light intensity.

C. Remove Camera Equipment.

(1) Remove adhesive tape and detach camera from probe. Ensure that probe does not fall free from engine.

(2) Remove equipment from vicinity of engine or transfer to the next area to be photographed.

D. Dismantle Camera Equipment.

(1) Remove camera from tripod.

(2) Remove film from camera.

(3) Remove adapter from camera lens filter thread.

(4) Remove adhesive tape used to lock adjustments and place camera in carrying case.

(5) Submit film for development, together with a copy of frame sequence/damage area identification record. Instruct that negatives and prints are identified accordingly and printed 6 in. by 4 in.

GENERAL - EGT TREND MONITORING

1. General

Engine health monitoring is carried out by analysing data recorded during stable supersonic cruise conditions using an
R approved pre-programmed hand held calculator or approved
R algorithms using a programmable calculator or palmtop PC
R of the operators choice. The calculator is used to establish the DELTA EGT between a Reference EGT derived from the flight and individual engine conditions and computed by the calculator, and the indicated EGT recorded at the stable cruise condition.

A trend is established for each engine by comparing the above DELTA EGT with the arithmetic mean of the values of DELTA EGT of the two previous supersonic flights for that engine.

If the DELTA EGT is plus/minus 20°C or more (the alert level) than the datum obtained above, it must be reported and the engine must be inspected before the next flight.

On engines where the vibration monitoring equipment has been rendered inoperative in accordance with the aircraft manufacturers Service Bulletin SST-77-009, this trend monitoring is Mandatory (ref. Mandatory Service Bulletin OL.593-72-8871-334) and must be carried out on every supersonic flight. There is no comparable EGT trend monitoring for subsonic flights.

B If the inflight data analysis is not possible e.g due to
B calculator or input parameter gauge not functioning, log the
B available data for retrospective analysis. The engine(s) may
B continue in service for a maximum of five supersonic flights
B (with a supersonic cruise greater than fifteen minutes) in
B accordance with the MMEL procedure. For wholly subsonic
B flights, and flights with a supersonic cruise of less than
B fifteen minutes, the engine(s) may continue in service for a
B maximum of ten flights or fifteen hours, whichever occurs
B first, prior to further trend analysis.

2. Obtaining Trend Plot

A trend plot for each engine should be produced as a maintenance task, by plotting both the arithmetic mean of the DELTA EGT's of the two previous supersonic flights and the DELTA EGT for a given flight on a flight by flight basis. The trend obtained by this method is more likely to indicate a gradual deterioration of engine performance. It should be reviewed in conjunction with the general health monitoring programme derived from AIDS to ensure that a gradual EGT shift can be recognised and acted upon where necessary.

An apparent step change may occur either after an engine change or after certain components or module changes have been made to an engine. In these cases, new trend plots must be started. Similarly, step changes may occur after instrumentation changes which may affect the supersonic cruise recorded parameters. Where obvious instrumentation errors have been corrected, a new trend plot must be started.

Typical EGT trend monitoring plots are shown in Figure 101.

3. Recording Data

For the purposes of EGT trend monitoring, supersonic cruise is defined as being met when:

- Cruise rating is selected
- E-High indicated
- Reheat off
- Throttle levers fully forward
- Mach No. between 1.90 and 2.04
- Altitude between 45000 ft and 60000 ft
- Supersonic cruise period exceeds 15 minutes.

The following parameters must be recorded:

- Flight identification and date
- Engine No. and position in aircraft
- Mach No. MN
- Altitude Ft
- Total air temperature TAT °C.

The following must be recorded for each engine:

- HP compressor speed, N_2%
- LP compressor speed, N_1%
- Exhaust gas temperature EGT°C.

4. Approved Calculators and Programme Loading Procedures (Figure 102)

A. Approved Calculators

The Sharp PC1246 calculator has been approved for use by British Airways.

NOTE: The Sharp PC1251 and Hewlett Packard Type 41CV
R or HP200LX calculators are also approved for use. Consult Propulsion Engineering.

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ΔEGT (DEGREES C)

50
40
30
20
10
0
-10

KEY

FLIGHT BY FLIGHT ΔEGT

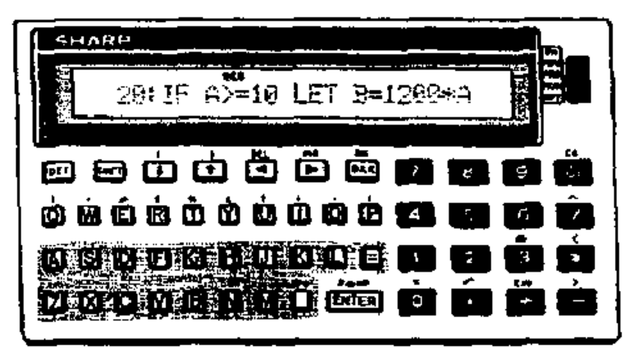
DATUM (MEAN OF 2 PREVIOUS FLIGHTS)

SHIFT >20 DEGREES
ENGINE CHANGE

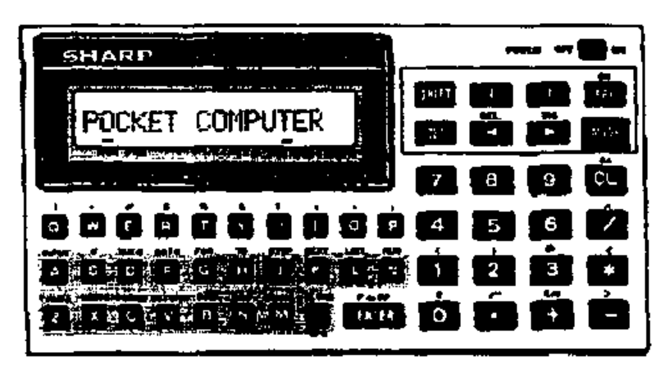
TIME (OR FLIGHT No)

Typical DELTA (Δ) EGT Trend Monitoring Plot Showing a DELTA (Δ) EGT Shift and Change of Data Level After an Engine Change
Figure 101

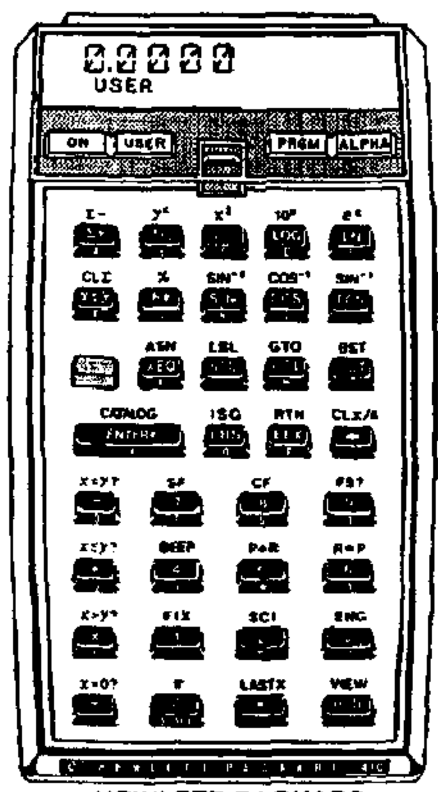
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SHARP TYPE PC 1251

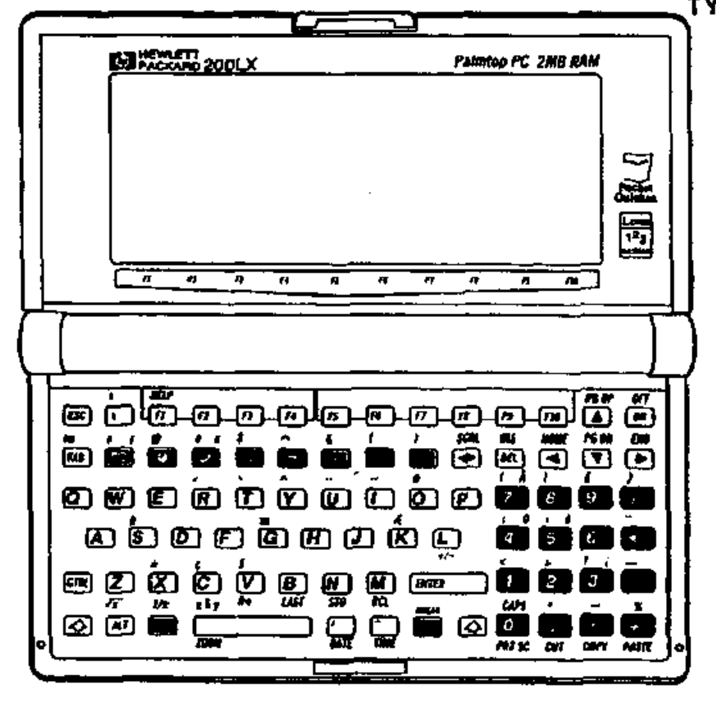


SHARP TYPE PC 1246



HEWLETT PACKARD
TYPE 41CV

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HEWLETT PACKARD
200LX

Keyboards for Calculators
Figure 102

B. Programme Loading Procedure for Sharp PC1246 Calculator

(1) Tools and Equipment.

Printer/Microcassette Tape Recorder	Sharp type CE125
Microcassette	Sharp ref. VB85/1 (PC1246); available from Rolls-Royce plc, containing recorded programme.

(2) Ensure that the calculator and tape recorder power REMOTE switches are off.

(3) Assemble the calculator to the tape recorder; if necessary, refer to the manufacturers handbook.

(4) Select/confirm tape recorder REMOTE switch is OFF.

(5) Insert the correct microcassette in recorder and zero the tape counter with the cassette fully rewound.

(6) Advance the tape to the vicinity of the recorded programme; refer to details supplied with cassette.

R

(7) Select the calculator power switch to ON.

R (8) Select the tape recorder REMOTE switch to ON.

R (9) Press the tape recorder play button.

Both calculators

(10) Type CLOAD followed by ENTER.

(11) The BUSY caption will illuminate and the display will show an asterisk as the programme is loaded into the calculator; the transfer will take about one minute.

(12) Completion of a successful transfer is indicated by the reappearance of the prompt > .

(13) If during loading, the message ERROR8 is displayed, it will be necessary to reprogramme commencing at operation (4). If necessary, refer to the manufacturers handbook.

(14) On satisfactory completion of programming the calculator, select the tape recorder REMOTE switch to off and as required, rewind tape.

(15) Run the test cases using the instructions given in sub para.C. If unsuccessful, reprogramme calculator commencing at operation (4); if necessary, refer to the manufacturers handbook.

(16) Switch off both the calculator and tape recorder power switches before removing calculator from tape recorder.

C. Programme Test Cases

(1) Using the instructions in para.5 for the relevant calculator, type in the following data:

Input	Output
Mach No. = 2.0	
Total air temperature, TAT = 117°C	
Altitude = 53000 ft	
HP compressor speed, N_2 = 103.9%	
LP compressor speed, N_1 = 101.3%	
Exhaust gas temperature, EGT = 643°C	
	REF EGT (°C) = 643
	DELTA EGT (°C) = 0

(2) If the test case in (1) is satisfactory, using the same procedure, type in the following data:

Input	Output
Mach No. = 2.01	
Total air temperature, TAT = 93°C	
Altitude = 54600 ft	
HP compressor speed, N_2 = 102%	
LP compressor speed, N_1 = 99%	
Exhaust gas temperature, EGT = 650°C	
	REF EGT (°C) = 619
	DELTA EGT (°C) = 31

(3) If either test case is not satisfactory, reprogramme the calculator and repeat the test cases.

D. Calculator Battery Life

(1) General.

The types of batteries and the method for changing them is detailed in the relevant manufacturers handbook. The programme may be lost during the fitting of new batteries in the calculator, therefore after every battery change, the programme should be checked using the test cases detailed in para.C.

(2) Sharp PC1246 calculator.

An indication that the batteries are reaching the end of their safe working life, will be given by the calculator display remaining dim even with full adjustment of the contrast control, together with the calculation of REF EGT and DELTA EGT taking perceptibly longer.

5. Calculation of DELTA EGT

A. DELTA EGT Calculation using Sharp PC1246 Calculator

(1) Preparation.

Select the calculator power switch ON.

The prompt > will appear at the left hand side of the display.

Select/confirm RUN mode indicated on display; if necessary use MODE selection key.

The calculator has a feature that switches off the display if no key is pressed for about 11 minutes, except if a programme is running. To restart the calculator in such circumstances press the ON key
BRK
and the calculator will restart with all settings exactly as they were when it went off.

(2) Execution.

	Input	Display
(a)	Press DEF key followed by M key	EGT TREND PROG appears for about 1 second, followed by MACH NO. = -
(b)	Type mach. no. recorded followed by ENTER	TOTAL TEMP = -
(c)	Type total air temperature (in °C) recorded followed by ENTER	ALTITUDE = -
(d)	Type altitude (in feet) recorded followed by ENTER	N_2 = -

	Input	Display
(e)	Type HP compressor speed N_2 recorded for subject engine followed by ENTER	
		N_1 = -
(f)	Type LP compressor speed N_1 recorded for subject engine followed by ENTER	
		EGT OBS, VED = -
(g)	Type EGT recorded for subject engine followed by ENTER	
		The display goes blank and the BUSY caption illuminates whilst the calculator computes REF EGT = -

NOTE: If required, the reference EGT for the subject engine may be recorded at this point.

(h)	To continue, type ENTER	
		DELTA EGT = -
	Record DELTA EGT for subject engine	
(j)	To calculate REF EGT and DELTA EGT for other engines in turn, type ENTER	
		N_2 = -

and continue for the subject engine from operation (e).

(k) At the end of the calculation, switch calculator power switch to OFF.

(l) If after operation (j), the flight conditions change, it will be necessary to repeat the calculations from the beginning, i.e. operation (a) after switching the calculator power switch to OFF.

(m) Entry error correction.

(i) If the error is made on entry in response to a display prompt message, but recognised before ENTER is pressed, use the red coloured CA key and retype data.
CL

(ii) If data is entered but outside the limits, then an appropriate message is displayed for approximately 2 seconds and the programme returns to its original prompt.

(iii) If data is entered and the message ERROR1 is displayed, use the red coloured CA key to return to the prompt.
CL

(iv) If mismanagement of the data occurs during the entry procedure, e.g. pressing ENTER before entering data to the prompt, it will be necessary to repeat the calculations from the beginning, i.e. operation (a) after switching the calculator power switch to off.

6. Exhaust Gas Temperature Trending Algorithms for use with a Suitable Programmable Calculator or Palmtop PC.

A. General

(1) EGT monitoring is employed as a means of identifying significant changes in engine condition from flight to flight. A programmable calculator or other portable computing device is provided with a simplified model of an average engine in supersonic cruise. Once the aircraft is established in supersonic cruise, the crew enters various engine parameters from each engine in turn, plus flight conditions, into the program and compares the actual EGT with that from the simplified model. If there is a significant change in the relationship between the two, the affected engine is subject to inspection on landing.

(2) The requisite algorithms have been previously defined. However they are defined in terms of input to a specific type of programmable calculator. Subsequently detailed are the algorithms in the form of mathematical equations, ready for translation into appropriate program coding.

R B. Required Inputs and Acceptable Ranges

R (1) Table 101 details the necessary input data and valid ranges.

Parameter	Maximum Value	Minimum Value
Mach no (M)	2.04	1.9
Total Air Temperature (T) °C	132	60
Altitude (Alt) feet	60000	46000
HP Speed (N2) %	105.3	97
LP Speed (N1) %	102	93
Exhaust gas temperature (EGT) °C	739	400

R Data outside the above ranges should be rejected by any program based on the information detailed in this section.

R Table 101

C. Algorithms

(1) The following calculations are required.

$$T1(K) = T + 273.15$$

$$Rt\theta = \sqrt{T1/399.115}$$

$$S = 0.0004299213 \times T1 - 0.1677380787$$

$$F = e^{(1.188605327 - 0.0000480639 \times (Alt - 36090))} \times (1 + 0.20014 \times M^2)^{3.4989}$$

$$N1C = N1 \div Rt\theta$$

$$N2C = N2 \div Rt\theta$$

$$G = (9.48685 \times 10^{-5} \times N1C^2 + 0.03408617 \times N1C - 1.3652645 \times M^2 + 8.171267 \times M - 0.0303082 \times N1C \times M - 8.23702) \times F$$

$$K = (0.0000967106 \times N1C^2 - 0.099810674 \times N1C - 0.0004929905 \times N2C^2 + 0.1330687987 \times N2C + 0.0005656496 \times N1C \times N2C - 3.07181$$

$$\textit{If } G > 11.8, \textit{ then } R = -0.008382994313 \textit{ otherwise } R = -0.006538487 \times G + 6.877154000000001 \times 10^{-2}$$

$$X = K \times T1 \times (R + S + 1) - 273.16$$

$$\delta EGT = EGT - X$$

BP00003397/1

DELTA EGT is the parameter, which is monitored to detect potential engine problems.

R D. Test Case

R (1) If the above algorithms have been implemented
R correctly, the following input should give the
R value of X as 643.

R (a) Mach no. 2.0

R (b) Total air temperature 117°C

R (c) Altitude 53000 ft

R (d) HP speed 103.9%

R (e) LP speed 101.3%

R (f) Exhaust gas temperature 643

R (g) Thus DELTA EGT should be zero.

R 7. <u>EGT Characteristic Datum</u>

A. General

(1) On newly installed engines, there may be a significant step change when establishing the new DELTA EGT datum when compared to that obtained on the previous engine (Ref. Figure 101). This can be caused by the normal scatter which exists between engines.

(2) When re-installing an engine into the same nacelle, an apparent EGT shift may be similarly observed, which could be associated with component or aircraft instrumentation changes carried out during engine removal.

(3) A new DELTA EGT datum must be established on every newly or re-installed engine.

(4) Where there has been a break in trend monitoring (ref. sub-paras.(1), (2) and (3)), then the flight data for the initial flights should be recorded and analysed to enable a new datum to be established.

(5) Component changes carried out when the engine is installed can also cause an apparent EGT shift and these are:

Jet pipe thermocouple harness (EGT spider)
Gauge changes to correct instrumentation errors on individual engine parameters, i.e. N_2, N_1, EGT gauges.

Problems affecting instrumentation or systems for input parameters, i.e. Mach No. altitude and total air temperature, should be indicated by apparent shifts on all engines.

B. Inspection Following an Alert Level

(1) The inspection requirements will be governed by the results of the DELTA EGT trend monitoring.

(2) For an alert level with an upward shift trend, a borescope inspection of the combustion chamber and HP turbine is required together with a visual and tactile inspection of the LP turbine.

(3) For an alert level with a downward shift trend, a borescope inspection of the HP compressor is indicated. If the inspection of the 3rd and 7th stages of the HP compressor rotor does not identify any damage, an examination of the remaining stages must be carried out. If no HP compressor damage inspect the combustion chamber and turbines.

(4) If following an upward or downward shift, the relevant inspection does not identify any defect, the recordings of the input parameters or one of the instruments may be suspect.

(5) Note that certain component changes particularly on jet pipe thermocouple harness assembly (spider) may cause an apparent DELTA EGT shift.

C. Inspection - Combustion Chamber

(1) Carry out the inspection/check detailed in 72-41-01.

(2) If the inspection is satisfactory, no further inspection is required until the next periodic inspection unless the flight recorded data indicates otherwise.

D. Inspection - HP Turbine

(1) Carry out the inspection/check detailed in 72-51-00.

(2) If the inspection is satisfactory, no further inspection is required until the next periodic inspection unless the flight recorded data indicates otherwise.

E. Inspection - LP Turbine

(1) Carry out a visual and tactile inspection of the nozzles and rotor blades at the turbine face.

(2) If the inspection is satisfactory, no further inspection is required until the next periodic inspection unless the flight recorded data indicates otherwise.

F. Inspection - HP Compressor

(1) Carry out the inspection/check detailed in 72-33-00.

(2) If the inspection is satisfactory, no further inspection is required until the next periodic inspection unless the flight recorded data indicates otherwise.

7. <u>Action to be Taken at LHR</u>

A. General

(1) In order to gain the maximum benefit from the EGT trend, it is necessary to maintain a plot at LHR, from figures supplied by the flight crew, with the intent of identifying a shift in the trend over the long term. This plot shall therefore be maintained separately from that kept by the flight crew.

B. Plotting & Interpretation of Results

(1) The Δ EGT for each supersonic flight will have been established by the flight crew and recorded in the Engineer Officer's Log.

<u>NOTE:</u> It is a Mandatory requirement that should a Δ EGT of plus/minus 20°C or more be observed, the engine must be inspected before further flight.

At each LHR visit, note and plot the Δ EGT's recorded for each supersonic flight flown since the previous LHR visit.

(2) Establish the "Mean of Engine" by means of a straight edge, parallel to the horizontal axis, passing through the last 10 flights <u>excluding</u> the <u>last 4 flights.</u>

(3) Establish the variation of Δ EGT about the Mean of Engine and compare this with the Alert levels as follows:

(a) If a single Δ EGT plot varies by plus/minus 20°C or more about the mean previously established, carry out an inspection of the engine as defined in para. 6.B.

(b) If two or more consecutive Δ EGT plots vary by plus/minus 15°C or more about the mean previously established, carry out and inspection of the engine as defined in para. 6.B.

(c) Check the Δ EGT plots for an overall general trend, paying particular attention both to any step change of plus/minus 10°C or more in the Mean of engine which is not associated with an engine change or the change of any component listed in para. B (4) below, and to any trend which is increasing or decreasing consistently. Any such variation is cause for inspection of the engine as defined in para. 6.B.

NOTE: Where there is any doubt concerning the interpretation of any trends, consult the relevant Propulsion Development Engineer.

(4) A shift in EGT may result from changing any one of the following components:-

(a) Engine
(b) EGT thermocouple harness
(c) ADC
(d) TAT/Machmeter gauges

Note that a change of ADC or TAT/Machmeter gauges may cause all four engine EGT trends to shift.

(5) Figures 103 to 107 inclusive give examples of EGT trends associated with various types of engine distress.

(a) Trend Monitoring - Combustion Chamber Failure (Ref.Fig.103).

An in flight shut down occurred on Engine CBE 030 following high vibration indication (both felt and indicated) followed by the loss of engine oil contents. Initial investigation into the high vibration revealed failure of an LP turbine blade with major secondary damage together with severe overheating and bulging of the combustion chamber outer case (CCOC).

Strip examination of the engine revealed the combustion chamber to be severely damaged with a section of the outer barrel approximately 120 sq.in. (77419 sq.mm) in area missing. The area extended from the No.1 cooling ring casquette rearwards into the dilution zone.

The turbine exhaust diffuser had suffered a complete circumferential fracture forward of the inner diffuser causing complete loss of the LP turbine bearing support. This loss of support had caused severe damage in the LP turbine bearing housing area, due to its rotation relative to the inner diffuser and outer exhaust diffuser, and the high out-of-balance forces generated in the engine caused severe labyrinth rubs. The LP compressor drive shaft rear section was also heavily rubbed due to contact with the HP compressor drive shaft.

A detailed investigation of the failure, including rig tests using the damage combustion chamber, established that the CCOC overheating was due to flame radiation as a consequence of the extensive combustion chamber outer barrel damage. The failure of the combustion chamber was initially due to the No.1 outer cooling ring lip extension which factured circumferentially over a length of approximately 10 in. (254 mm) due to fatigue development. In turn, this resulted in flow reversal in the downstream No.2 cooling ring and subsequent burning of the primary zone and beyond due to thermal cracking.

A detached section of the combustion chamber outer barrel had wrapped around the HP turbine nozzle vane asemblies which caused the failure of the LP turbine blade in fatigue. Analysis of flight data, from a number of flights prior to the incident, revealed that at take-off, an upward shift in EGT of approximately 40 Deg.C took place between three to six flights prior to the failure flight.

Similarly, an analysis of flight deck recorded data at cruise conditions, with the failed engine at the same flight conditions i.e. 'Brochure Values', revealed a similar step change but not as significant as at the take-off conditions: the step change only taking place some two to three flights prior to the failure flight.

The above trend monitoring suggests that combustion chamber deterioration occurred over some 20 to 25 flights, and the CCOC overheating occurred during the last three of these flights.

(b) Trend Monitoring - Combustion Chamber Failure (Ref. Fig.104).

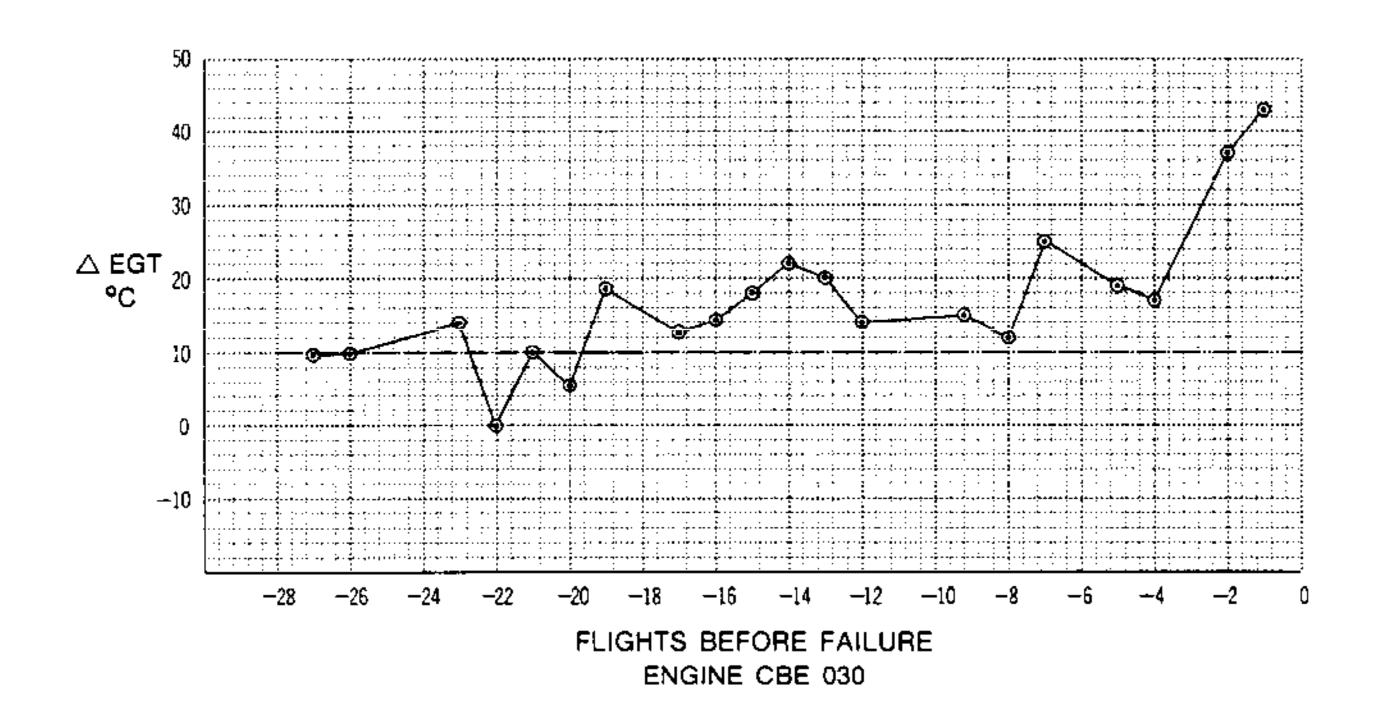
Trend monitoring of Engine CBE 022 adequately indicated the need for a borescope inspection.

An outer barrel failure was found to have initiated in the No.3 cooling ring (No.1 cooling ring not being affected). Approximately 80 sq.in. (51612 sq.mm) of outer barrel was missing and stator blockage had also occurred. Laboratory examination revealed some CCOC overheating was evident but bulging was negligible.

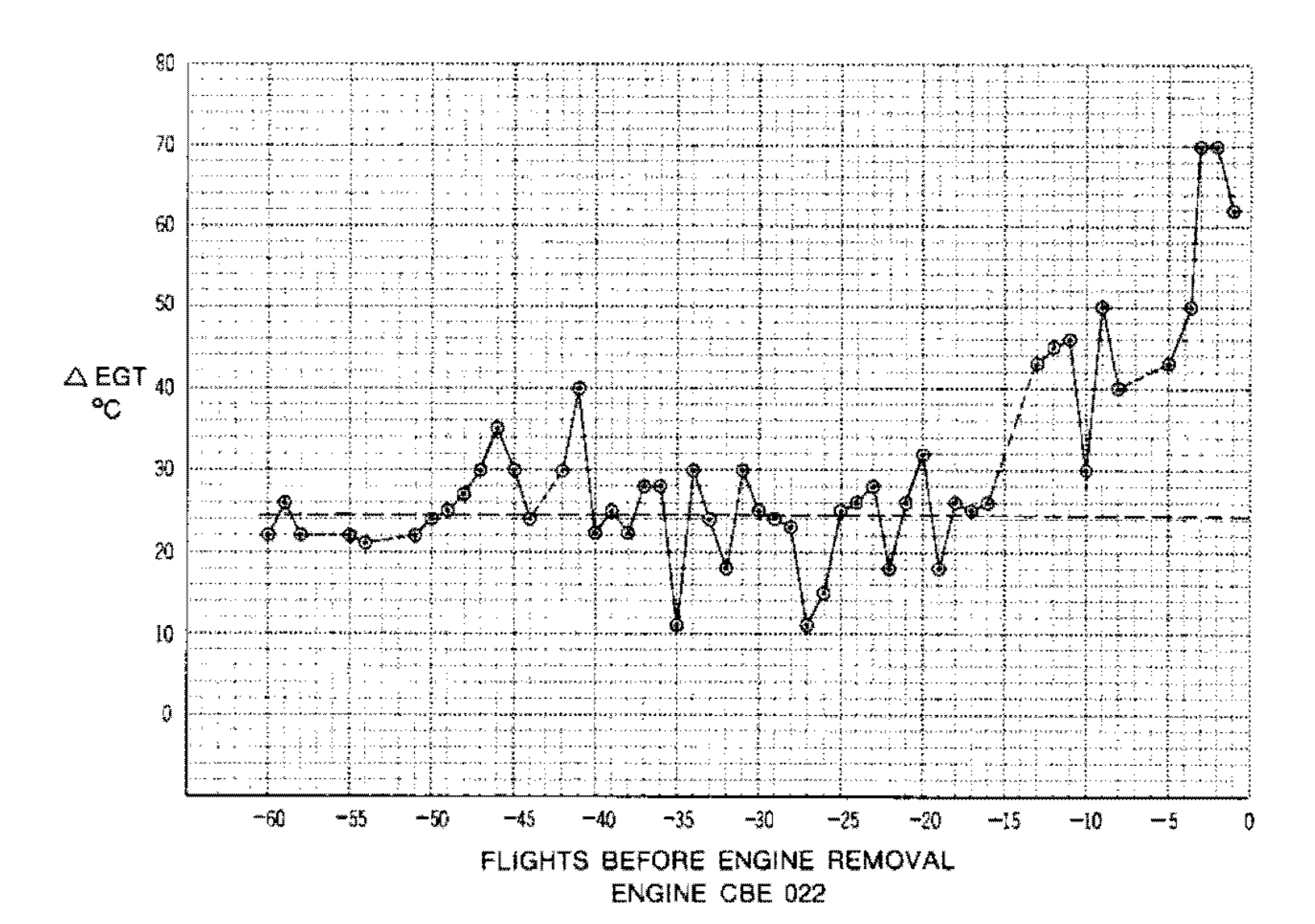
(c) Trend Monitoring - Combustion Chamber Failure - (Ref. Fig.105).

Trend monitoring of Engine CBE 071 had not indicated the need for a borescope inspection although a trend is evident. An outer barrel failure was found to have initiated in the No.1 cooling ring. Approximately 85 sq.in. (54838 sq.mm) of outer barrel was missing extending rearwards to the dilution zone. CCOC overheating and bulging to a height of 0.17 in. (0,43 mm) had occurred. The damage was found during a periodic inspection and subsequent disassembly.

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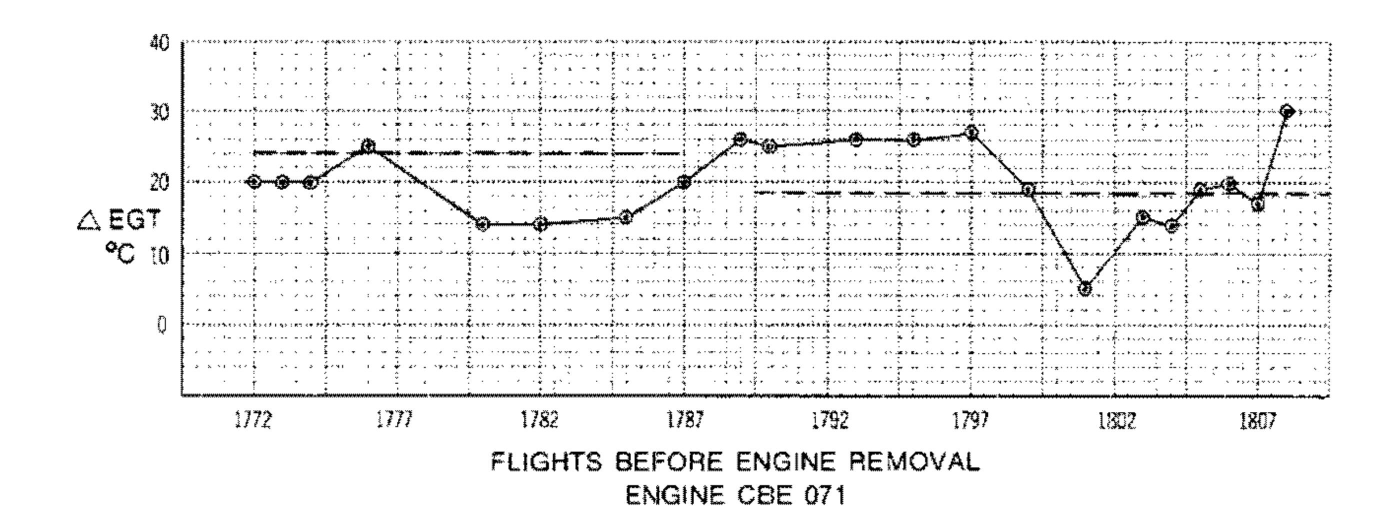


R B Example of Trend Monitoring -
R B Combustion Chamber Failure
R B Figure 103



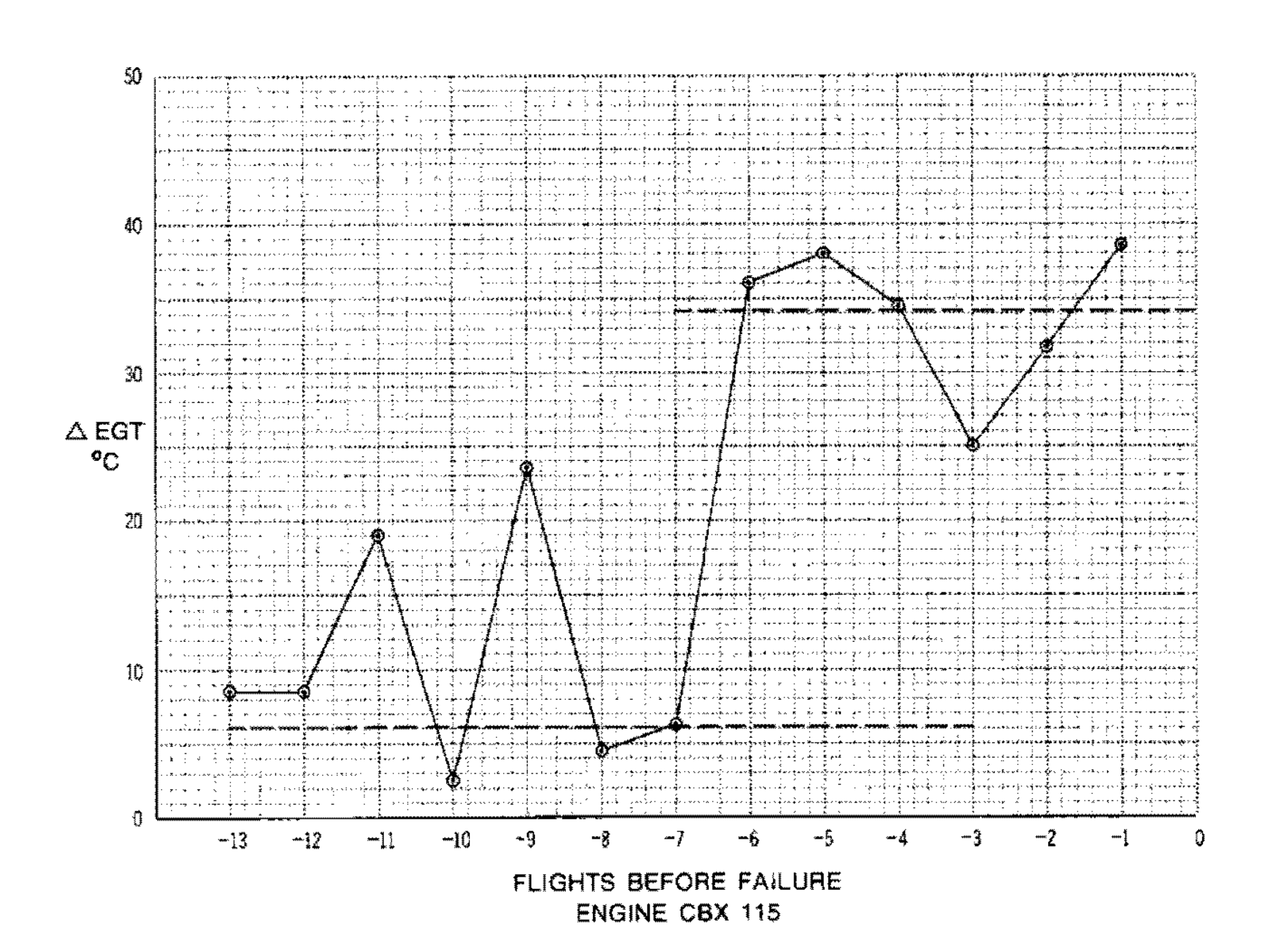
R B Example of Trend Monitoring -
R B Combustion Chamber Failure
R B Figure 104

CR 36107/00A



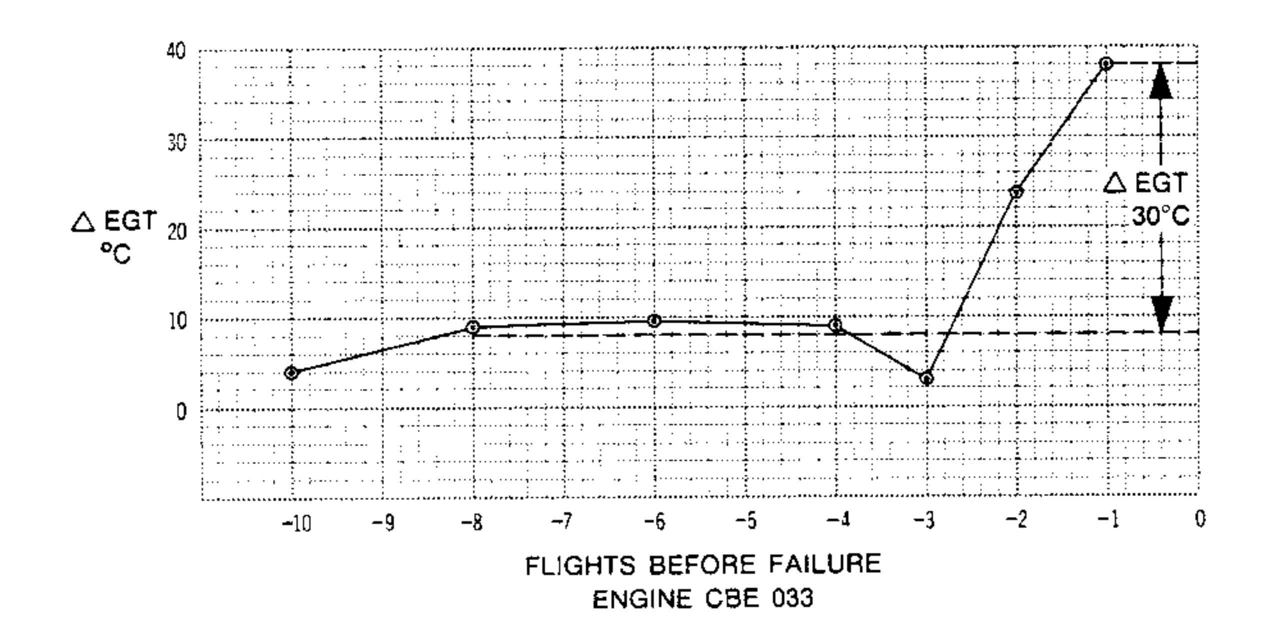
R B
R B
R B

Example of Trend Monitoring -
HP Turbine Blade Failure
Figure 105



R B Example of Trend Monitoring -
R B HP Turbine Blade Failure
R B Figure 106

CR 36109/00A



R B Example of Trend Monitoring -
R B HP Turbine Blade Failure
R B Figure 107

AIR INLET SECTION - DESCRIPTION AND OPERATION

1. General

The air inlet section is the front section of the engine and is bolted by its rear flange to the front face of the low pressure compressor case. The front flange of the inlet section is secured to a rear transition ring that joins the engine to the aircraft air intake.

2. Description

The air inlet section, shown in the illustration (Ref. Fig.001), comprises an inner and outer case joined by five hollow equally spaced vanes to form a duct assembly. The vanes are numbered clockwise viewed from the rear, No.1 vane being at the top of the outer case. The front flange of the outer case accommodates the clamp assembly which secures the aircraft rear transition ring to the engine. An anti-icing air manifold is mounted externally on the periphery of the outer case as described in 75-10-00 and forms the distribution passage for the anti-icing air to the vanes.

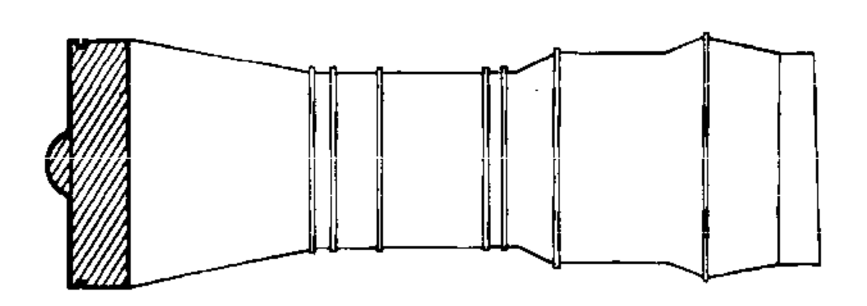
The inner case carries a baffle assembly and the LP compressor front bearing support housing. The single row roller bearing
R is enclosed by a bearing housing cover. A vibration transducer,
R which is used for engine test purposes only, is mounted on the
R bearing housing cover. A nose fairing, double skinned to provide a passage for the anti-icing air is bolted to the front flange baffle assembly.

The bearing housing and front cover form a sealed bearing compartment and prevent oil leakage into the air flow. Oil transfer tubes for bearing lubrication and vent tubes for bearing pressurizing air are accommodated in No.3 and 4 vanes. The bearing oil feed tube passes through No.4 vane and the scavenge tube passes through No.3 vane. Both vanes enclose air vent tubes while a tube in No.3 vane provides a route for the engine vibration transducer cable. Flanges bolted externally provide connections for external tubes of the oil and air vent systems.

3. Operation

The air inlet section forms the duct through which air, entering from the aircraft air intake, is passed to the LP compressor. Air from the anti-icing manifold passes through the vanes to the inner casing where it is directed by the baffle through holes in the support housing flange into the nose fairing and is finally exhausted into the LP

CR 30367/00B



OUTER CASE

FRONT FLANGE

VANE

INNER CASE

BEARING SUPPORT HOUSING

R

VIBRATION TRANSDUCER

LP COMPRESSOR SHAFT

R

BEARING HOUSING COVER

NOSE FAIRING

BAFFLE

Air Inlet Section
Figure 001

compressor air stream.

R Oil circulation to the bearing housing takes place through
R the transfer tubes and pressurizing air which passes into
R the bearing housing through the seals is vented overboard
R via the port and starboard vent tubes.

AIR INTAKE FAIRING - REMOVAL/INSTALLATION

WARNING: DO NOT ENTER AIR INTAKE WHEN AIRCRAFT HYDRAULIC POWER IS AVAILABLE.

1. General

On an installed engine it is necessary to enter the aircraft air intake for access to fairing.

2. Tools and Equipment

Cover, protection, for engine intake aperture	...	PE.12325
Circuit breaker safety clip		-

3. Intake Fairing (Ref.Fig.401)

A. Prepare to Remove Intake Fairing.

(1) Prepare aircraft air intake for entry (Ref.71-00-00, Servicing).

(2) Position protection cover in engine intake aperture in front of compressor.

B. Remove Intake Fairing.

(1) Unscrew nuts and pull fairing squarely forward in progressive stages until nuts can be removed.

(2) Support fairing, remove nuts and lift fairing away.

R C. Remove the Damper Spring (Ref.SB.OL.593-72-8746-284 or
R SB.OL.593-72-9005-409) (Ref.Fig.402).

R (1) Unscrew the tapered end of the damper spring.

R (2) Remove the damper spring from around the hollow of
R the air intake fairing plunged hole.

R (3) Remove and discard existing glass cloth tape.

D. Installation of Damper Spring to the Air Intake Fairing (Ref. SB.OL.593-72-8746-284) (Ref.Fig.402).

(1) Cut 1.000 in. (25,4 mm) wide glass cloth tape (OMat 2/76) into two strips 0.500 in. (12,7 mm) wide by approx. 9.000 in. (228,6 mm) long. Apply one strip to the damper spring location, then repeat with the second strip. Ensure the start of the second tape run is close to the end of the first tape run, but not overlapping, to prevent the layers of tape becoming too uneven.

(2) If the spring is formed into a loop, unscrew the tapered end from the free end and release the spring.

(3) Mark the tapered end of the spring to enable the number of turns to be counted when the two ends are screwed together (Ref.70-00-12 - Temporary Marking).

(4) Pre-load the spring by holding the free end and twisting (unscrewing) the tapered end two turns, then screw the tapered end into the free end for half a turn.

(5) Check that the two ends have engaged with each other, and if not, release the spring and repeat operations (3) and (4).

(6) Screw the tapered end into the free end one more turn.

(7) Assemble the looped spring around the hollow of the air intake fairing plunged hole.

E. Installation of Damper Spring to the Air Intake Fairing (Ref. SB.OL.593-72-9005-409) (Ref.Fig.402).

(1) Cut 1.000 in. (25,4 mm) wide glass cloth tape (OMat 2/76) into two strips 0.500 in. (12,7 mm) wide by approx. 9.000 in. (228,6 mm) long. Apply one strip to the damper spring location, then repeat with the second strip. Ensure the start of the second tape run is close to the end of the first tape run, but not overlapping, to prevent the layers of tape becoming too uneven.

(2) Mark the tapered end of the spring to enable the number of turns to be counted when the two ends are screwed together (Ref.70-00-12 - Temporary Marking).

R (3) Assemble spring. The reduced end of close coil spring is to be subject to reverse twist (anti-clockwise) of three turns and screwed clockwise into the open end to lock and form a circle. In the free state the spring must lie flat without twists.

R (4) Assemble the looped spring around the hollow of the air intake fairing plunged hole.

R F. Install Intake Fairing.

(1) Check that all work is completed, components and clips are secure and that area to be enclosed is clean and free from loose objects.

(2) Apply lubricant B (Ref.70-00-01, Servicing and Storage Materials) to attachment nuts.

B (3) Check that damper spring is assembled to flare of plunged hole in fairing inner skin (SB.OL.593-72-8746-284 and SB.OL.593-9005-409 standard).

B (4) With fairing aligned with cut-out section facing lead support clip bracket, hold fairing squarely with bolts projecting slightly through fairing flange.

(5) Assemble a nut to each bolt and push the fairing squarely rearward until the bolts ends just protrude through the nuts with threads engaged.

<u>NOTE:</u> S.B. OL.593-72-8532-195 standard bolts have a plain lead end before the threads.

(6) Press fairing fully home ensuring that spigot engaged squarely.

(7) Torque-tighten nuts to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

R G. Complete the Installation.

(1) Carefully remove protection cover from air intake and ensure that the intake is free from loose items or material.

(2) Remove equipment from air intake and make system operative (Ref.71-00-00, Servicing).

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A

AIR INTAKE CASE

FORWARD

BLANK

SB 72-8532-195

A

PRE SB 72-8532-195

INTAKE FAIRING

Air Intake Fairing and Location Detail
Figure 401

CR 36638/00B

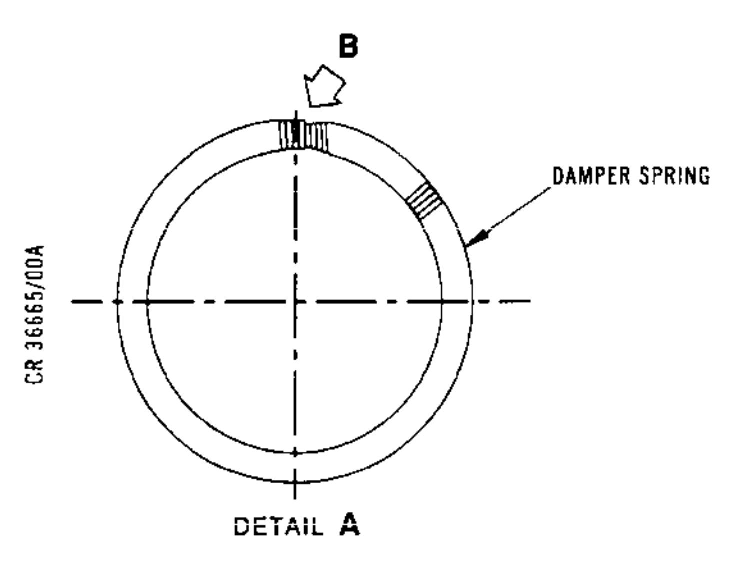
DAMPER SPRING

SECTION THROUGH
AIR INTAKE FAIRING

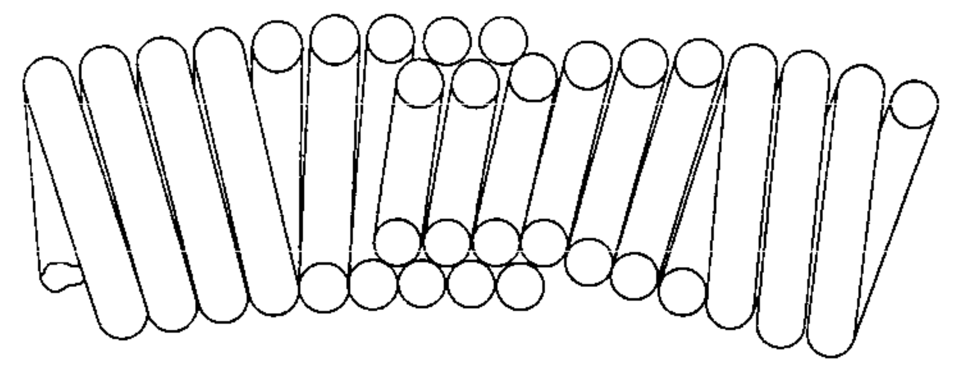
DETAIL A
(SEE SHEET 2)

DAMPER SPRING

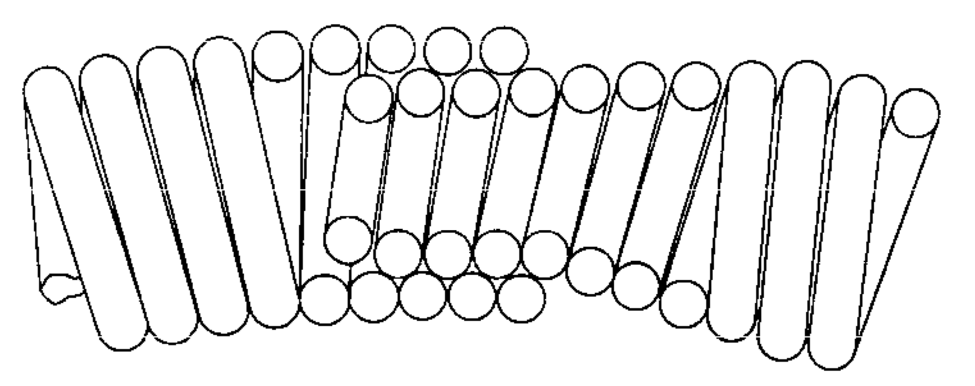
Air Intake Fairing with Damper Spring
Figure 402 (Sheet 1 of 2)



DETAIL A



VIEW ON B
(TO SB 72-8746-284 STANDARD)



VIEW ON B
(TO SB 72-9005-409 STANDARD)

Air Intake Fairing with Damper Spring
Figure 402 (Sheet 2 of 2)

AIR INTAKE FAIRING - INSPECTION/CHECK

WARNING: DO NOT ENTER AIR INTAKE WHEN AIRCRAFT HYDRAULIC POWER IS AVAILABLE.

1. General

The air inlet section consists of an air intake case and an air intake fairing. This chapter states the acceptable
R limits of damage to the air intake fairing outer skin in
R paragraph 4 and the fairing inner skin in paragraph 5.
R The acceptable limits for the air intake case are given in
R 72-22-01, Inspection/Check.

On an installed engine it is necessary to enter the aircraft air intake to gain access to the air intake fairing.

2. Terminology for Damage

A. Apply the Following Definitions to the Terms Used to Describe Damage.

(1) Crack. Visible partial separation of material which may progress to a complete break, (a break is defined as a separation by force into two or more pieces).

(2) Dents. An indentation usually caused by impact of an object; parent metal is displaced, seldom separated.

(3) Gouge. Material scooped out from surface of the part.

(4) Nick. A sharp surface indentation.

(5) Piercing. Puncture of the material.

(6) Score. Deep scratch.

(7) Scratch. Light, narrow, shallow mark; material is not removed.

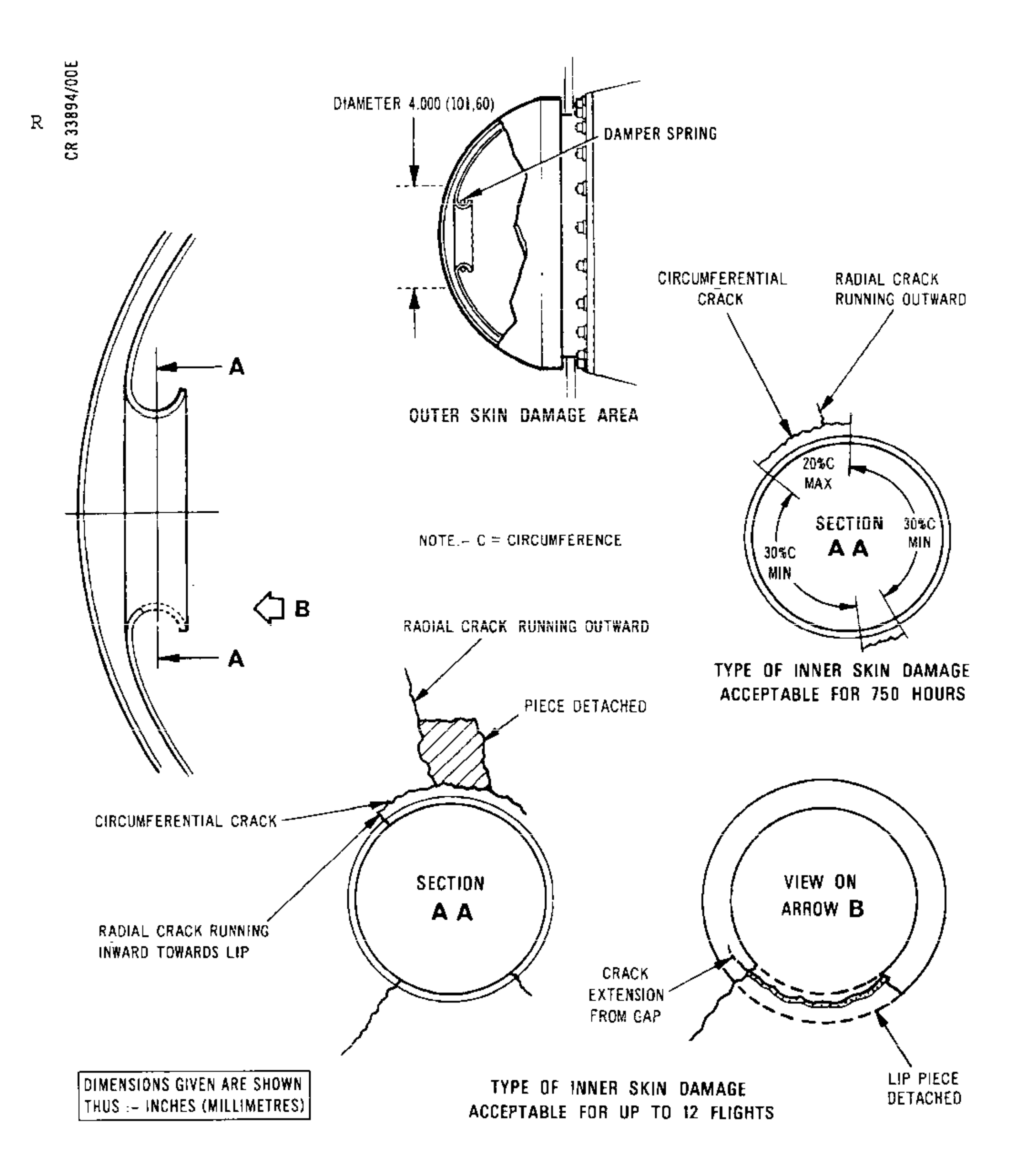
(8) Tear. Separation by pulling apart.

3. Examination of Air Intake Fairing

A. Examine Air Intake Fairing.

(1) Observe the safety precautions and prepare the aircraft intake for entry as detailed in chapter

R



Air Intake Fairing - Identification of Damage Areas
Figure 601

71-00-00, Servicing.

(2) Enter the aircraft air intake and remove the air intake fairing (Ref.72-21-01, Removal/Installation).

R (3) Damper Spring SB OL.593-72-8746-284 or
R SB OL.593-72-9005-409 standard. Check the spring
R is assembled to the flare of the plunged hole in
R the air intake fairing inner skin (Ref. Fig.601)
R and that the glass cloth tape between the spring
R and the flare surface is in good condition and not
R worn through.

<u>NOTE:</u> If the damper spring is detached or missing from its location, inspect, as far as possible, for entrapment of the spring or spring debris between the inner and outer skins of the air intake fairing. Inspect the engine for damage. (Refer 71-00-00 Inspection/Check for Foreign Object Damage.)

(4) Examine the air intake fairing and record type and extent of any damage found using the terms given in paragraph 2 and by reference to the illustration (Ref.Fig.601).

(5) Assess the acceptability of any damage by comparison of the examination results with the acceptance standards stated for the inner and outer skin.

(6) After completion of the examination, install the air intake fairing, remove equipment from air intake and make system operative (Ref.72-21-01, Removal/Installation and 71-00-00, Servicing).

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4. <u>Acceptance Standards For Fairing Outer Skin</u>

A. Acceptable Limit of Damage.

(1) Smooth dents covering an area no greater than 2.50 in. by 2.00 in. (63 mm by 50 mm) and less than 0.200 in. (5,0 mm) deep provided they are at least 3.00 in. (75 mm) apart and do not encroach on the central area of the fairing covered by a 4.00 in. (100 mm) diameter circle, (Ref.Fig.601).

(2) Smooth dents covering an area no greater than 2.50 in. by 2.00 in. (63 mm by 50 mm) and less than 0.100 in. (2,5 mm) deep provided they are at least 1.00 in. (25 mm) apart and do not encroach on the central area of the fairing covered by a 4.00 in. (100 mm) diameter circle, (Ref.Fig.601).

(3) Nicks, scores and scratches up to 0.005 in. (0,13 mm) deep, provided all raised burrs are lightly dressed.

B. Reject Air Intake Fairing if Damage is as Follows:

(1) Fails to meet the acceptable limits stated in paragraph A.

(2) Cracks or tears.

(3) Dents within the central area of the fairing covered by a 4.00 in. (100 mm) diameter circle, (Ref. Fig. 601).

(4) Sharp dents with a bottom radius of less than 0.050 in. (1,3 mm).

(5) Gouges or piercing of the skin.

5. <u>Acceptance Standards for Fairing Inner Skin</u> (Ref. Fig. 601)

A. Acceptable Limit of Damage for a Further 750 Hours Engine Running.

(1) Subject to inspection when exposed during other work, circumferential and radial cracks are acceptable within the limits given in paragraphs (2) and (3) for a further 750 hours of engine running.

(2) Circumferential cracks are acceptable provided that:

(a) A crack does not exceed a length equivalent to 20% of the circumference measured at the crack location.

(b) The total length of all the cracks does not exceed 40% of the circumference.

(c) There is an undamaged space of not less than 30% of the circumference separating the ends of adjacent circumferential cracks.

(3) Radial cracks are acceptable provided that:

(a) The crack runs outward from a circumferential crack.

(b) A crack does not exceed 0.10 in. (2,54 mm) in length.

(c) There is not less than 30% of the circumference separating adjacent radial cracks throughout their length.

(d) If the damage exceeds the preceding limits of acceptance, assess the damage against the limits stated in paragraph B for possible acceptance for a further twelve flights.

(4) Holes may be drilled at the ends of the cracks within acceptable limits if considered advantageous. Follow standard practice using a drill of between 0.079 and 0.118 in. (2 and 3 mm) diameter.

B. Acceptable Limit of Damage for up to Twelve More Flights.

(1) Circumferential and radial cracks and detached pieces of the inner skin are acceptable within the limits given in paragraphs (2), (3) and (4) respectively.

(2) Circumferential cracks are acceptable provided that:

(a) A crack does not exceed a length equivalent to 30% of the circumference measured at the crack location.

(b) The total length of all the cracks does not exceed 50% of the circumference.

(c) There is an undamaged space of not less than 25% of the circumference separating the ends of adjacent cracks. Two short adjacent cracks with less than the acceptable separation are acceptable provided that, when the two cracks and the distance between the adjacent ends are measured as a total length and assessed as one crack, the limits of paragraphs (a) and (b) are not exceeded.

(3) Radial cracks running outwards, either separately or from a circumferential crack, are acceptable provided that:

(a) The crack does not exceed 1.50 in. (38,10 mm) in length.

(b) There is not less than 20% of the circumference separating adjacent radial cracks throughout their length.

(4) Radial cracks running inwards, either separately or from a circumferential crack, towards the lip are acceptable provided that:

(a) The crack does not exceed 0.15 in. (3,81 mm) in length and is not less than 0.25 in. (6,35 mm) away from the lip.

(b) There is not less than 25% of the circumference separating adajcent radial cracks.

(5) Detached pieces, associated with circumferential and radial cracks, are acceptable within the following limits.

NOTE: A piece that is about to become detached can be removed before measuring and assessing damage.

(a) Areas from which pieces are missing and are outward of a circumferential crack at the lip are acceptable provided that:

(a1) The area is contained within a circle of 0.7 in. (17,78 mm) diameter. If this limit is exceeded, refer to paragraph (a3).

(a2) There is not less than 35% of the circumference separating the nearest edges of adjacent areas of missing skin.

(a3) A single area only in excess of the limit stated in paragraph (a1) is acceptable provided that it is contained within a circle of 0.866 in. (21,996 mm) diameter and the edge of the hole or any radial crack running from it is separated from any adjacent radial crack by at least 20% of the circumference.

(b) Pieces missing from the lip are acceptable provided that:

(b1) The length of missing lip does not exceed 25% of the circumference.

(b2) Any circumferential cracking extending from the missing area along the remaining lip does not exceed more than 0.50 in. (12,70 mm) in length.

(b3) Adjacent radial cracks running inward towards the lip are separated from the missing lip area by at least 30% of the circumference.

(6) Holes may be drilled at the ends of the cracks within acceptable limits if considered advantageous. Follow standard practice using a drill of between 0.079 and 0.118 in. (2 and 3 mm) diameter.

RB 6. Inspection of Support Webs (Ref.Fig.602)

R B NOTE: This procedure should only be carried out by personnel having been trained and approved in eddy current inspection.

R B A. Visually Inspect.

R B (1) Visually inspect the fairing for broken or missing webs. Any fairing with one or more webs missing must be removed and a replacement installed (Ref. Concorde Maintenance Manual 72-21-01).

R B (2) Visually inspect the webs for surface damage likely to cause false indications when using an eddy current probe e.g. dents, scratches, and raised surfaces. Raised surfaces may be lightly stoned (Ref.Overhaul Manual 72-09-00 Repair).

R B B. Eddy Current Inspect.

R B (1) Equipment.

R B (a) Elotest B1 eddy current test instrument.

R B (b) Aluminium test block with 1 mm deep slot.

R B (c) Test kit S3S 14791000 comprising probe and probe guide (Ref.Fig.603).

(2) Prepare the equipment.

(a) Plug the probe (and balance coil if required) into the Elotest B1, switch on, and set as follows:

Frequency	:	3.0 MHz
Band width	:	HF
Preamplifier	:	-6dB
Gain	:	X/Y 20dB/14dB
Phase	:	188 degrees
Dot position	:	X/Y 20/26
Filter	:	Lowpass 50 Hz

(b) Apply a small strip of Teflon protective tape to the probe tip to prevent wear.

(3) Calibration and lift-off checks.

(a) Place the probe tip on the calibration block, clear of the slot and the edges. Balance the Elotest instrument.

(b) Adjust the spot on the display until it appears in the bottom right-hand area of the screen.

(c) Adjust the phase of the Elotest B1 until lift-off produces a horizontal spot movement to the left of the screen (Ref.Fig.604).

(d) Traverse the 1 mm deep slot on the calibration block, moving the probe tip across the centre of slot at right angles. Adjust the gain of the Elotest B1 until the vertical component of the signal is three major divisions (Ref.Fig.604).

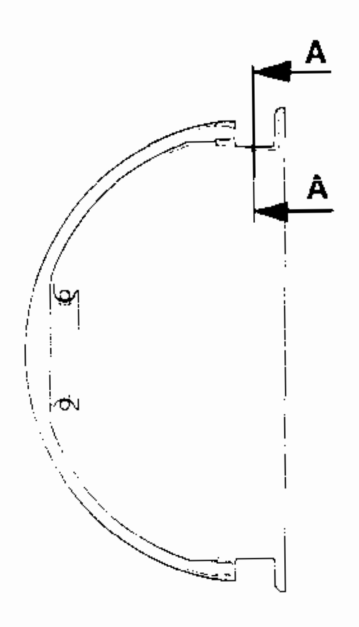
(e) Place the probe tip on the air intake, and balance the Elotest instrument.

(f) Adjust the phase of the Elotest B1 until lift-off produces a horizontal spot movement to the left of the screen (Ref.Fig.604).

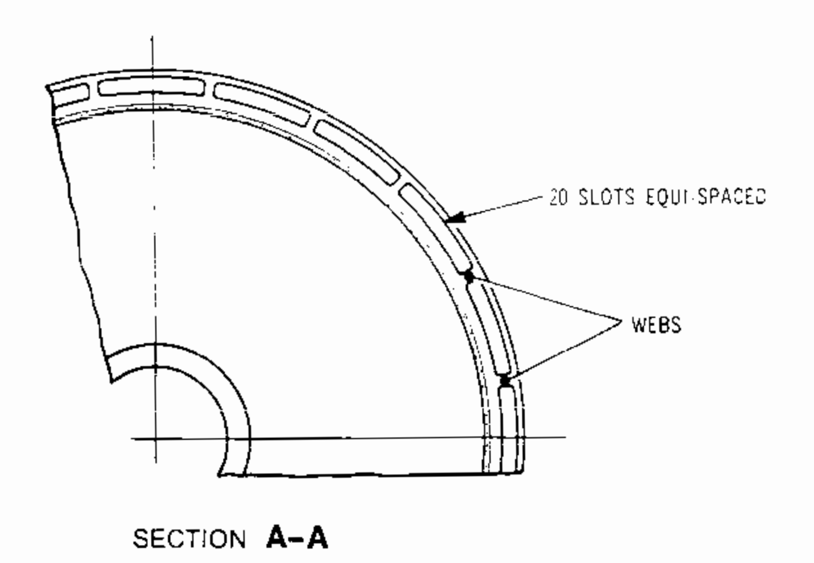
(4) Inspection.

(a) Place the probe guide on the air intake fairing so that the guide block enters one of the 20 slots in between the webs (Ref.Figs.602 and 603).

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SECTION THROUGH AIR INTAKE FAIRING

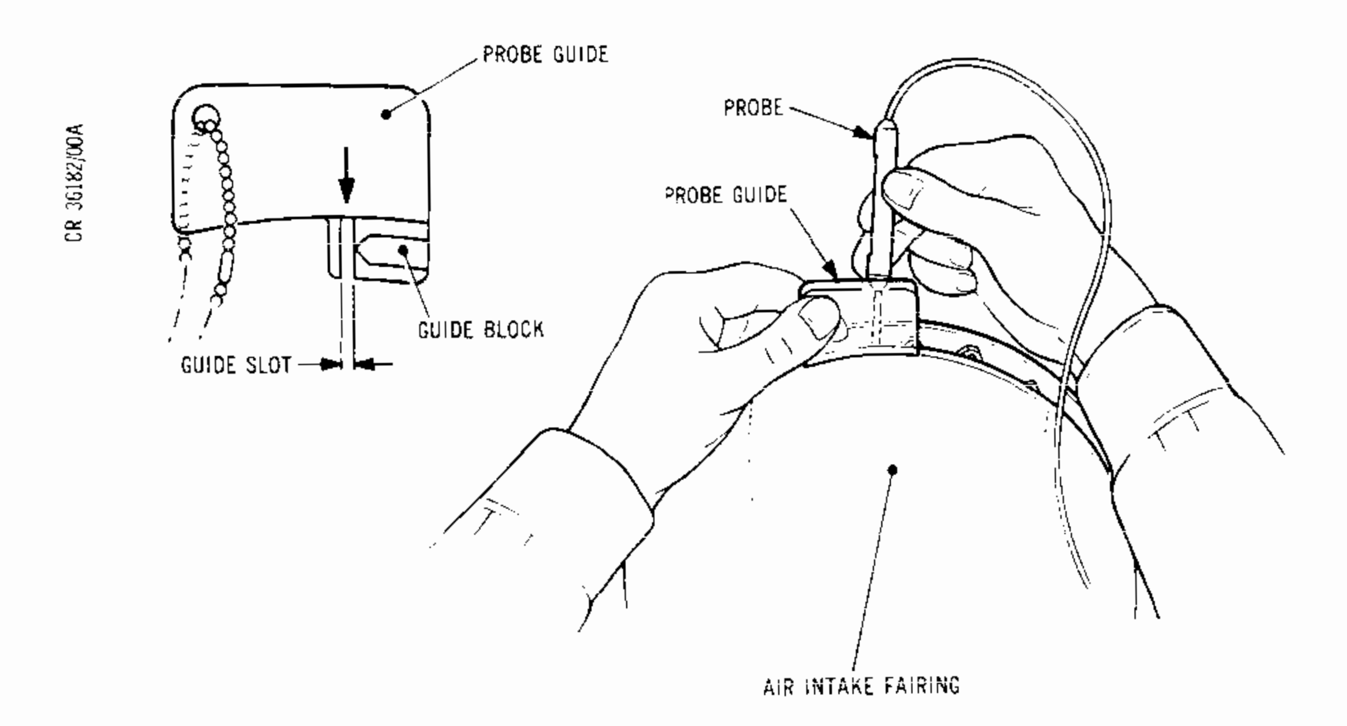


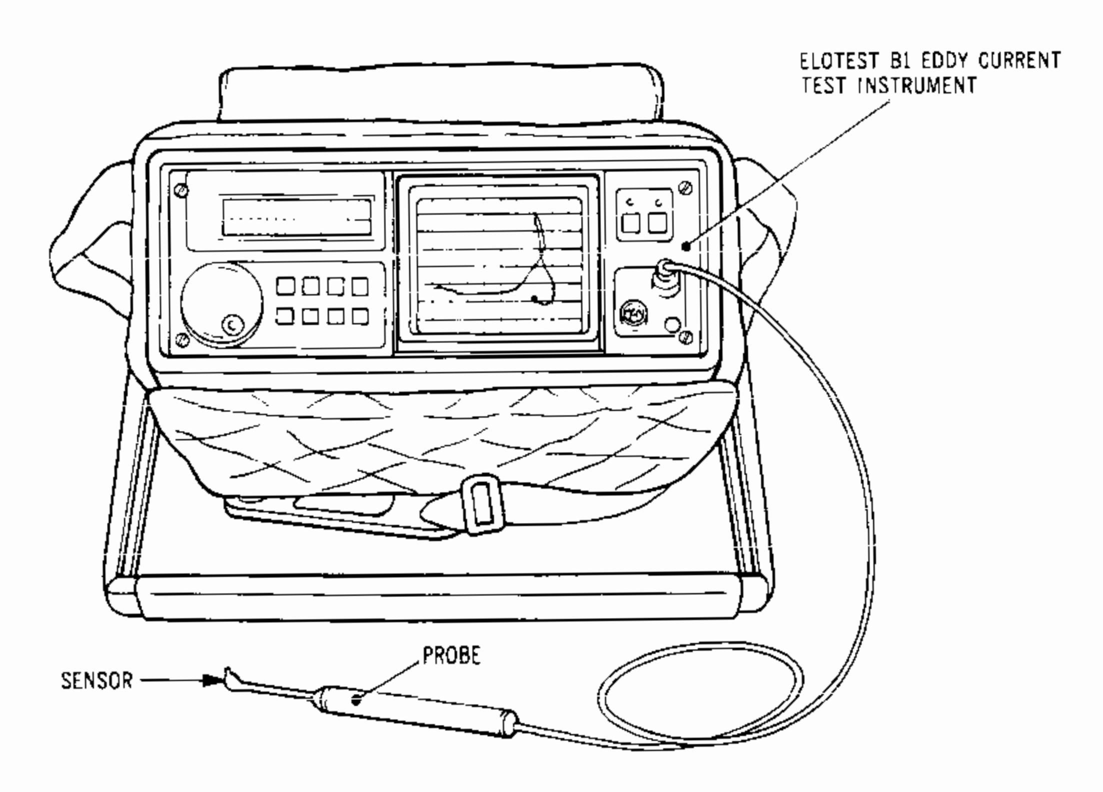
SECTION **A-A**

Air Intake Fairing
Figure 602

B

CR 3G182/00A





Test Equipment
Figure 603

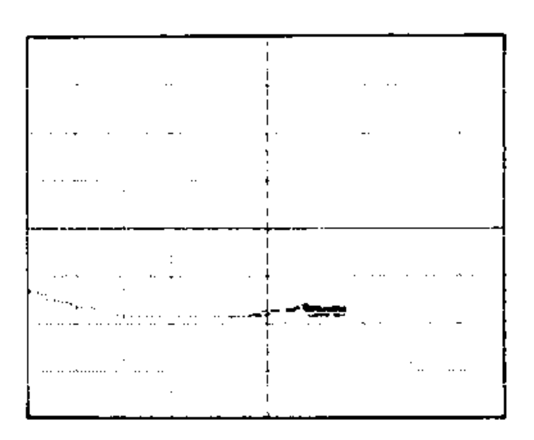
B

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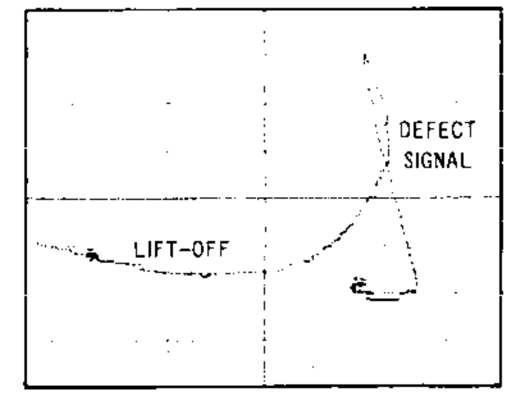
SIGNAL FROM SLOT

LIFT-OFF

SCREEN INDICATION FOR ALUMINIUM CALIBRATION BLOCK



SCREEN INDICATION FOR COMPONENT LIFT-OFF CHECK



SCREEN INDICATION FOR TYPICAL DEFECT

Test Instrument Screen Indications
Figure 604

B

(b) Move the probe guide anti-clockwise until the guide block touches the web. The guide slot is now in position over the web.

(c) Insert the probe into the guide slot (indicated by an arrow), and move the probe tip along the web.

(d) Observe the Elotest screen for any indication of vertical movement of the spot. Any web displaying indications which cannot be attributed to probe handling or geometric effects should be considered defective.

(e) If a defect is indicated, mark the position on the outer skin, using temporary marking (Ref. Overhaul Manual 72-09-00 Assembly).

(f) Repeat the procedure in paragraphs 6.B(4)(a) to 6.B(4)(e) for the remaining 19 webs.

(g) Repeat the calibration and lift-off procedure in paragraphs 6.B(3)(a) to 6.B(3)(c), and without adjusting the gain control, check that the vertical component of the signal from the slot is at least three major divisions. If this is not the case, the calibration has altered and the inspection must be repeated.

(h) If the air intake fairing has one or more defective webs, it must be removed and a replacement installed (Ref.Concorde Maintenance Manual 72-21-01).

C. Complete the Inspection.

Remove all equipment and loose items from the aircraft air intake, and return the aircraft to service (Ref.Concorde Maintenance Manual 71-00-00 Servicing).

AIR INTAKE CASE - INSPECTION/CHECK

WARNING: DO NOT ENTER AIR INTAKE WHEN AIRCRAFT HYDRUALIC POWER IS AVAILABLE.

1. General

The air inlet section consists of an air intake case and an air intake fairing. This chapter states the acceptable limits of damage to the air intake case. The acceptable limits for the air intake fairing are given in 72-21-01, Inspection/Check. For ease of maintenance, combine the two procedures. On an installed engine it is necessary to enter the aircraft air intake to gain access to the air intake case.

The air intake case has been divided into sub-sections as follows to facilitate reference to the limits of acceptance (Ref.para.4.A.).

VANES
INNER CASE
OUTER CASE

2. Terminology for Damage

A. Apply the following definitions to the terms used to describe damage.

(1) Crack. Visible partial separation of material which may progress to a complete break, (a break is defined as a separation by force into two or more pieces).

(2) Dent. An identation usually caused by impact of an object; parent metal is displaced, seldom separated.

(3) Distortion. Excessive deformation of the original contour of the part, (associated terms, buckle, depression, twist, warp).

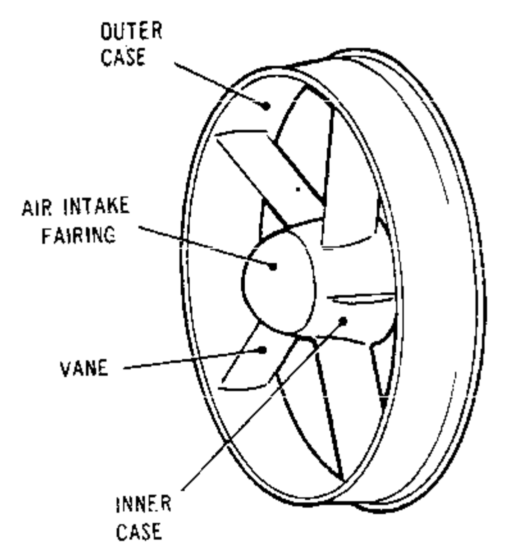
(4) Gouge. Material scooped out from surface of the part.

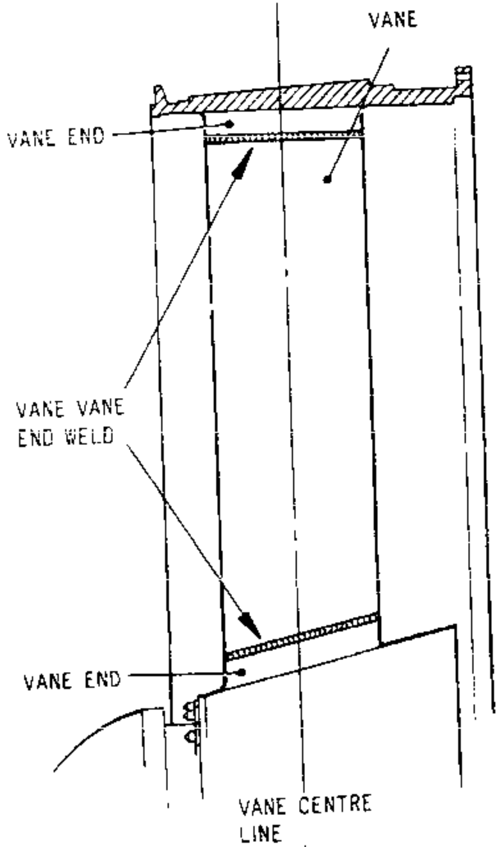
(5) Nick. A sharp surface indentation.

(6) Piercing. Puncture of the material.

(7) Score. Deep scratch.

CR 33899/00A





CMR 72 22 01 6 AAM0

Air Intake Case - Identification
of Damage Areas
Figure 601

(8) Scratch. Light, narrow, shallow mark; material is not removed.

(9) Tear. Separation by pulling apart.

3. Examination of Air Intake Case

A. Examine Air Intake Case.

(1) Observe the safety precautions and prepare the aircraft intake for entry as detailed in chapter 71-00-00, Servicing.

(2) Enter the aircraft air intake and, in a good light, examine the air intake case. Record damage to sub-sections using the terms given in paragraph 2 and by reference to the illustration (Ref. Fig. 601).

(3) Assess the acceptability of any damage by comparison of the examination results with the acceptance standards stated in paragraph 4.

(4) After completion of the examination, remove equipment from air intake and make system operative (Ref. 71-00-00, Servicing).

4. Acceptance Standards

A. Air Intake Case.

R (1) Acceptable limit for cracks in vanes.

(a) One crack, up to a maximum length of 1.5 in. (40 mm), in each vane, provided the crack runs at about 45 degrees, (within 10 degrees of that
R figure), to the vane centre line, or,

R (b) One crack, longer than 1.5 in. (40 mm) but not
R more than 3 in. (75 mm) long, in each vane, provided the crack runs at about 45 degrees, (within 10 degress of that figure), to the vane centre line and is checked by drilling a stopper hole within the range of 0.09375 in. to 0.1875 in. (2,5 mm to 4,5 mm).

R (2) Acceptable limit for damage (excluding cracks) to
R vanes.

R (a) Smooth dents up to 0.125 in. (3,175 mm), provided there is at least 6.0 in. (150 mm) between each dent.

R (b) Distortion of the leading or trailing edge, provided the lateral displacement does not exceed 0.250 in. (6,4 mm) and there is only one buckle or kink on each vane.

R (c) One gouge with its greatest dimension not exceeding 0.750 in. (19 mm), or two gouges each with the greatest dimension not exceeding 0.375 in. (9,5 mm), on each vane provided all raised burrs are lightly dressed.

R (d) Nicks, provided all burrs are lightly dressed and those in the leading and trailing edges are not more than 0.030 in. (0,76 mm) deep and are suitably blended.

R (e) Piercing of the vane skin, provided the greatest dimension of the hold does not exceed 0.125 in. (3,175 mm) and there are no more than two holes in each vane of a maximum of three vanes.

R (f) Scores, up to 0.50 in. (13 mm) long, provided all raised burrs are lightly dressed.

R (g) Scratches, provided any raised burrs are lightly dressed.

R (3) Acceptable limit of damage to inner case.

(a) Smooth dents up to 0.125 in. (3,175 mm) deep, provided there are no more than two per inter-vane space and they are not less than 2.0 in. (50 mm) apart.

(b) One gouge with its greatest dimension not exceeding 0.750 in. (19 mm), or two gouges each with the greatest dimension not exceeding 0.125 in. (3,175 mm), on each inter-vane space provided all raised burrs are lightly dressed.

(c) Nicks, scores up to 0.50 in. (13 mm) long and scratches, provided all raised burrs are lightly dressed.

R (4) Acceptable limit of damage to outer case.

(a) Smooth dents up to 0.125 in. (3,175 mm) deep, provided there are no more than two per inter-vane space and they are not less than 6.0 in. (15o mm) apart.

(b) One gouge with its greatest dimension not exceeding 0.750 in. (19 mm), or two gouges each with the greatest dimension not exceeding 0.375 in. (9,5 mm), on each inter-vane space provided all raised burrs are lightly dressed.

(c) Nicks, scores up to 0.50 in. (13 mm) long and scratches, provided all raised burrs are lightly dressed.

R (5) Reject an air intake case if damage is as follows:

(a) Fails to meet the acceptable limits stated in paragraphs (1), (2) and (3).

(b) Cracks near the vane/vane end weld and running parallel to the weld.

(c) Cracks in the vanes which propagate beyond their stopper holes.

(d) Tears in the vanes.

(e) Any damage to a vane which results in deformation of the opposite side of the vane, with the exception of leading or trailing edge distortion which must comply with the limits given in paragraph (1) (d).

(f) Cracks or tears in the inner case, outer case or vane ends.

(g) Piercing of the inner case skin, outer case skin or vane ends.

LP COMPRESSOR FRONT BEARING - REMOVAL/INSTALLATION

1. General

On an installed engine, access to the LP compressor front bearing is obtained from the aircraft air intake, and necessitates the removal of the air intake fairing.

The removal and installation procedures are identical for both Pre S.B. OL.593-72-30 and S.B. OL.593-72-30 standard.

2. Tools and Equipment

Extractor	S3S 1240000
Bearing extractor and assembly tool ...	PE.23302
Wedge assembly...	PE.35498
Jacking tool	S3S 12427000
Extractor assembly	S3S 12426000
Circuit breaker safety clip	-

3. Prepare to Remove Bearing

A. Remove Air Intake Fairing.

(1) Comply with the WARNINGS and CAUTIONS, trip the circuit breakers and remove the air intake fairing as detailed in 72-21-01.

R

R 4. Remove Bearing (Ref. Fig.401 and 402)

A. Remove Bearing Outer Track.

(1) Disconnect engine vibration transducer cable connector from transducer.

R (a) On engines to pre S.B.OL.593-77-8611-26 standard, remove the locking clip, then unscrew the cable connector from the transducer.

R (b) On engines to S.B.OL.593-77-8611-26 standard, unscrew the connector.

R (c) Discard the sealing ring.

(2) Remove bearing housing cover.

R CAUTION: DO NOT REMOVE BOLTS (10) SECURING BEARING HOUSING TO AIR INTAKE CASE.

(a) Remove 24 bolts securing cover and note position of transducer cable bracket for installation purposes.

(b) Screw three slave bolts (0.250 in. 28 UNF) into the cover extraction holes and withdraw the cover, together with gasket, from engine.

(3) Remove bearing retaining plate.

(a) Remove seven bolts securing bearing retaining plate to the bearing housing.

(b) Unscrew the centre shaft of the extractor assembly to the fully withdrawn position.

(c) Locate the extractor body in the inner diameter of the retaining plate then turn extractor to engage its dogs with the rear face of the retaining plate. Hold extractor in this position and screw in the centre shaft until the clamping pad contacts the rotor shaft front end cover.

(d) Grip the knurled portion of the extractor body and, with a hand pull applied, manipulate the extractor to withdraw the retaining plate from its location. Detach retaining plate from extractor.

(4) Support LP compressor rotor.

(a) Position the jacking tool in the LP compressor case with its pivot wheel just forward of the first stage rotor disk.

(b) Raise the jacking tool handle and locate the jacking pad under the first stage rotor disk, between blades at the bottom centre position.

(c) Apply a downward pressure to the jacking tool handle until the pivot wheel remains vertically below the jacking pad and the compressor rotor is fully supported.

(d) Insert wedges between first stage lower rotor blades and the LP compressor case.

(5) Ensure that the weight of the rotor is taken on the jacking tool and wedges, then carefully withdraw the bearing outer track by hand.

B. Remove Bearing Inner Track.

(1) Remove four bolts securing rotor shaft front end cover and withdraw the cover with the extractor.

R (2) Prepare extractor and assembly tool (Ref. Fig. 402).

R (a) Unscrew and remove the threaded shaft from the
R tool and detach the mandrel.

R (b) Assemble threaded shaft and mandrel to rotor
R shaft front.

R (b1) Locate the base of the threaded shaft on
R the inside face of the rotor shaft front,
R clear of the captive nuts. Maintain the
R shaft in this position while carrying out
R the assembly sequences of paragraphs (ii)
R and (iii).

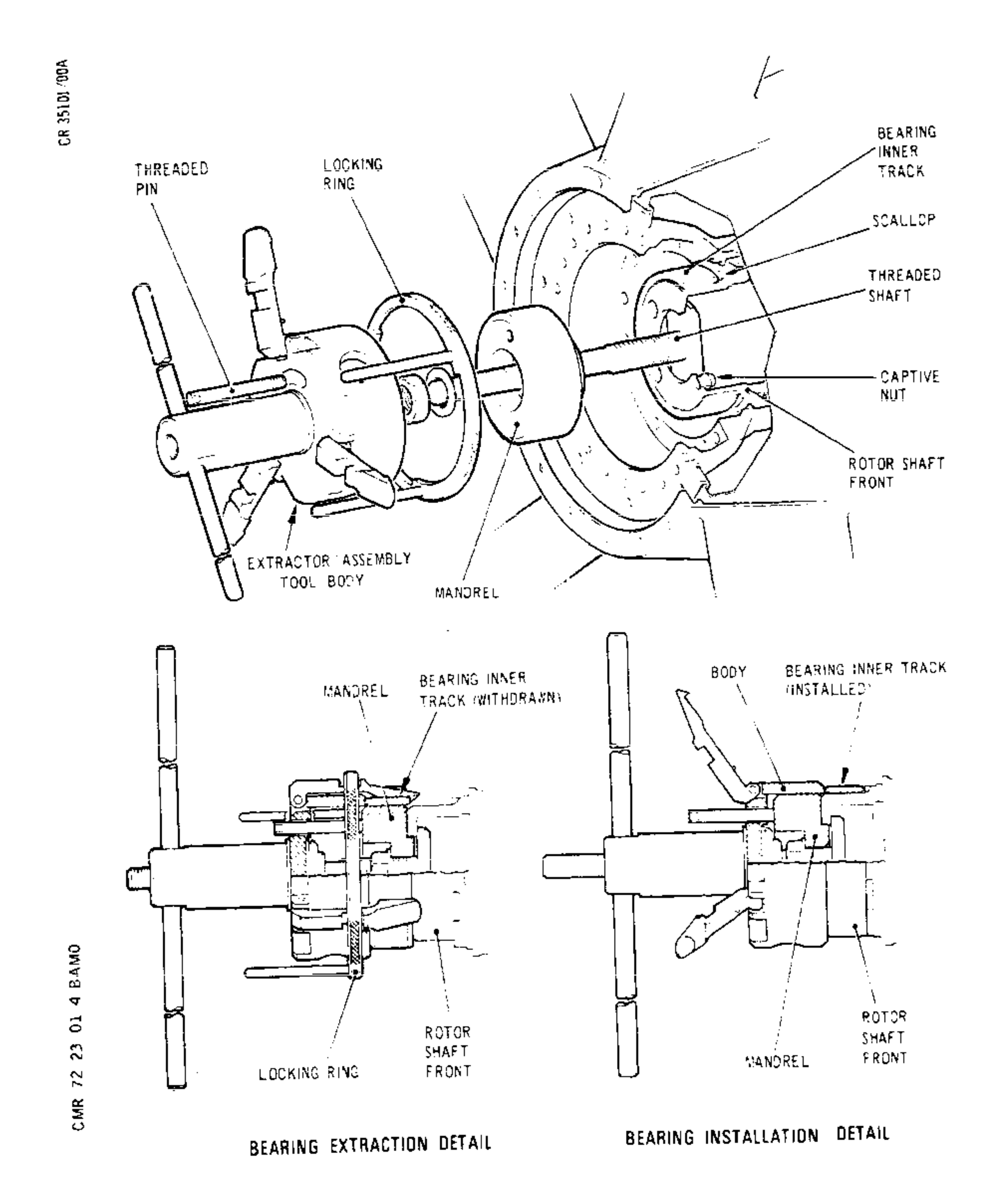
R (b2) Assemble the mandrel over the threaded
R shaft and engage its locating diameter in
R the aperture in the face of the rotor
R shaft front.

R (b3) Assemble the flat washer, followed by the
R nut, to the threaded shaft. Check that
R the base of the shaft is clear of the
R anchor nuts, then tighten the nut against
R the mandrel.

ROTOR SHAFT FRONT END COVER
LOCKING CLIP
SEALING RING
BEARING OUTER TRACK
BEARING INNER TRACK
SB 77-8611-26
PRE SB 77-8611-26
CR 34132/00B
SEALING RING
VIBRATION TRANSDUCER
BEARING HOUSING COVER
ENDFLOAT
FRONT BEARING
GASKET
RETAINING PLATE
BEARING HOUSING
DETAIL OF END-FLOAT CHECK
CMR 72 23 01 4 AAMO

LP Compressor Front Bearing Details
Figure 401

R



Bearing Inner Track Extractor and Assembly
Tool Details
Figure 402

R

(c) Ensure that the locking ring is located in the grooves of the extracting legs with its pins protruding toward the handle.

(d) Turn the locking ring to the position (unlocked) which provides maximum clearance between the extractor and assembly tool body and the extracting legs, then assemble the body to the threaded shaft and engage the threads.

(e) When initial thread engagement is obtained, turn the body to align its slot with the threaded pin location in the mandrel.

(f) Assemble the threaded pin through the slot and screw it into the mandrel.

NOTE: The threaded pin will prevent the body from turning during its travel along the threaded shaft.

(g) Screw the extractor and assembly tool body, by means of the handle, onto the threaded shaft and, when the extracting claws are positioned just to the rear of the bearing inner track rear edge, turn the body to align the claws with the scallops in the rotor shaft front.

(h) By means of the pins, turn the locking ring sufficiently in the direction of locking (counter-clockwise), to hold the extracting legs in light contact with the bearing inner track surface.

(j) By turning the handle, screw the body further onto the threaded shaft, then, when full assembly is obtained, slowly withdraw the body to engage the claws with the rear edge of the bearing inner track.

(k) Turn the locking ring further to lock the extractor legs firmly against the surface of the bearing.

(3) Extract the bearing inner track by turning the handle in a counter-clockwise direction.

NOTE: The bearing inner track has an interference fit with the rotor shaft front and considerable resistance is apparent during the extracting operation.

R (4) Release the locking ring and remove the body from the threaded shaft.

R (5) Remove the bearing inner track from the mandrel.

R 5. <u>Install Bearing</u> (Ref. Fig.401 and 402)

R A. Install Bearing Inner Track.

R (1) Assemble the bearing inner track, with its part number facing toward the front of the engine, to the extractor and assembly tool mandrel.

R (2) Push the inner track rearward until it contacts the rotor shaft front, then, with a hide face mallet, lightly tap the leading edge of the bearing to obtain initial engagement with the rotor shaft front.

R (3) Prepare extractor and assembly tool (Ref. Fig. 402).

R (a) Remove the locking ring.

R (b) With the extracting legs pointing toward the handle, assemble the body to the threaded shaft and engage the threads.

R (c) When initial thread engagement is obtained, turn the extractor and assembly tool body to align its slot with the threaded pin location in the mandrel.

R (d) Assemble the threaded pin through the slot and screw it into the mandrel.

R (4) Screw the body, by means of the handle, onto the threaded shaft until it contacts the bearing.

R (5) Continue to turn the extractor and assembly tool handle in a clockwise direction until the bearing is fully assembled to the rotor shaft front.

R (6) Remove the extractor and assembly tool and carry out a check with a 0.0015 in. (0,0381 mm) feeler gauge at the rear of the bearing to verify that it is fully assembled.

B. Install Bearing Outer Track.

(1) Ensure that the rotor shaft front is centralized in the bearing compartment.

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(2) Apply lubricant A (70-00-01, Servicing and Storage Materials) to the bearing inner track and carefully assemble the bearing outer track to the bearing housing.

(3) Assemble the bearing retaining plate (raised shoulder toward bearing) to the bearing housing and secure with seven bolts with lubricant B applied. Torque-tighten the bolts to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

R (4) Push the bearing outer track rearwards and measure the end-float between the shoulder of the retaining plate and the bearing outer track (Ref. Fig. 401) to ensure that the retaining plate is correctly located. This gap must be not less than 0.003 in. (0,076 mm) and not more than 0.004 in. (0,102 mm).

(5) Assemble rotor shaft front end cover to rotor shaft front and secure with four bolts with lubricant B applied. Torque-tighten bolts to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(6) Install bearing housing cover.

(a) Apply lubricant B to attachment bolts.

R (b) With new gasket S.B.OL.593-72-15) between mating faces and assembly pin engaged, hold bearing housing cover in position on bearing housing.

(c) With transducer cable bracket in the position noted during removal, retain the cover with 24 bolts lightly tightened locating the two longer bolts at the bracket position.

(d) Torque-tighten bolts to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(7) Connect engine vibration transducer cable connector to transducer.

(a) Position a new sealing ring against shoulder of connector end and then assemble connector to transducer receptacle.

R (b) On engines to pre S.B.OL.593-77-8611-26 standard, torque-tighten transducer connector nut to between 60 and 100 lbf in. (6,8 and 11,3 N.m) until castellations of nut align with those of adjacent nut. Engage locking clip with

castellations and if clip is to S.B.OL.593-71-11 standard, wire-lock clip ends together.

(c) On engines to S.B.OL.593-77-8611-26 standard, torque-tighten transducer connector nut to between 60 and 100 lbf in. (6,8 and 11,3 N.m). Wire-lock connector nut.

C. Complete the Installation.

(1) Remove jacking tool and wedges from the compressor rotor.

(2) Check the LP compressor rotor for freedom to rotate.

(3) Install air intake fairing as detailed in 72-21-01.

R
R (4) Carry out an engine ground run to check for oil leaks in respect of the LP compressor front bearing after engine shut down (Ref.71-00-00, Adjustment/Test, Table 503).

COMPRESSOR SECTION - DESCRIPTION AND OPERATION

1. General

The compressor section extends from the rear of the air inlet section to the front of the combustion section, where the compressor diffuser case joins the combustion chamber outer case, and to where the HP and LP shafts join the turbine section.

2. Description

The compressor section, shown in the illustration (Ref. Fig. 001), consists of LP and HP compressor assemblies that are separated by an intermediate case and have a diffuser case at the rear. Each compressor assenbly has a case and vanes enclosing a bladed rotor assembly. The HP rotor connects directly to its turbine assembly whereas the LP rotor has a splined drive shaft connection.

Each compressor case is bolted to the intermediate case, the LP to the front flange and the HP to the rear. The diffuser case is bolted to the HP compressor case rear flange. The intermediate case has an inner and outer case spaced by six hollow vanes whereas the diffuser case has an inner and outer case joined by eight hollow vanes. The LP compressor drive shaft is retained by a locking tube that extends to the rear of the shaft. The rear ends of the tube and shaft carry a differential twist signal system generating mechanism.

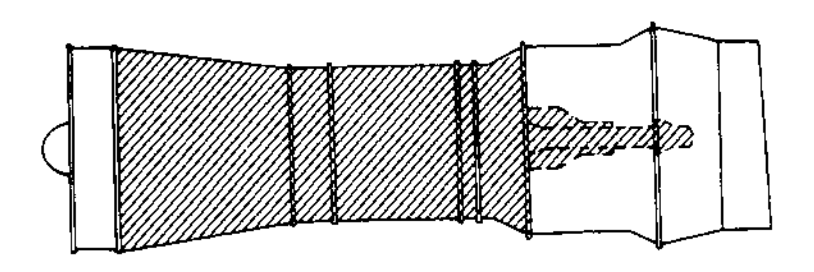
3. Operation

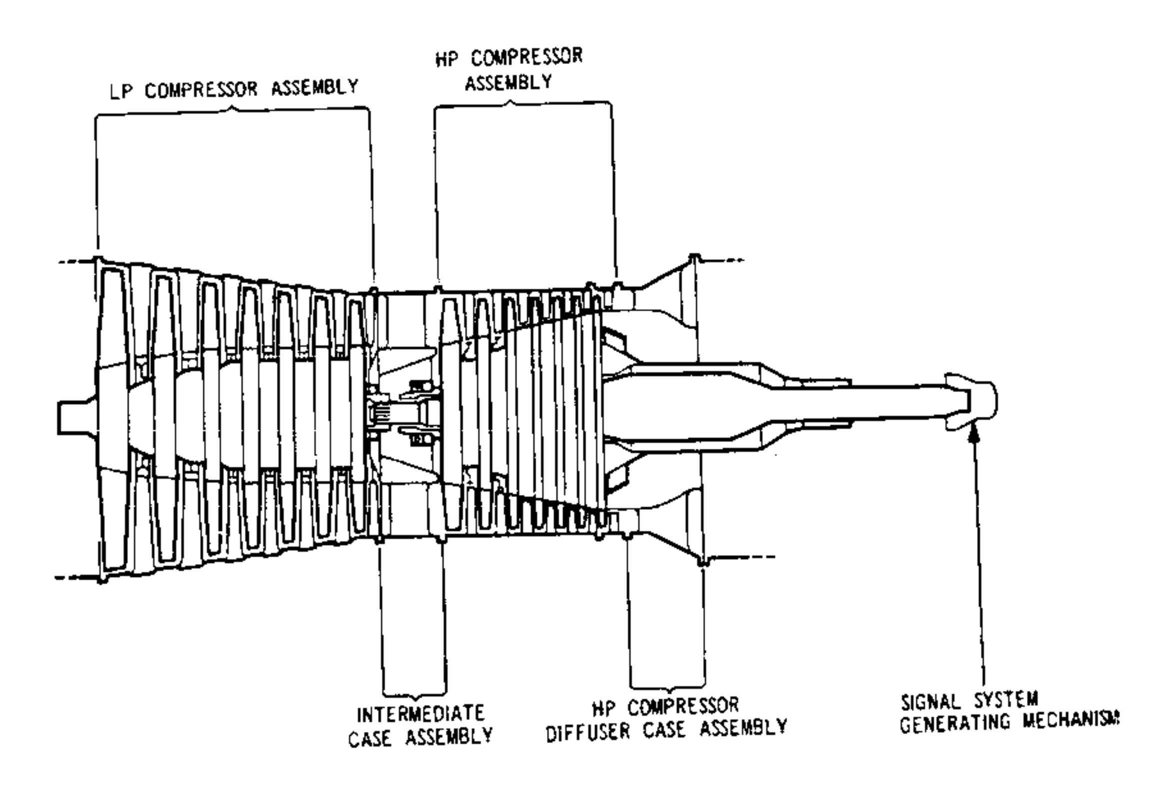
Air directed by the air inlet case passes through the compressor section from the LP compressor to the diffuser case via the stages of each compressor and the intermediate case. Within each stage, comprising a set of rotor (rotating) blades and a set of stator (fixed) vanes, a pressure increase is achieved in approximately equal amounts from each set of blades and vanes.

The intermediate case supports the thrust bearings and forms the air transfer passage between the LP compressor and HP compressor assemblies. The vanes transmit the bearing load from the inner to the outer case and house lubrication system tubes and accessory drive shafts.

There is a progressive reduction in cross sectional area of the passage through the compressors until the air is discharged from the last stage of the HP compressor into the divergent duct formed by the diffuser case. The air then enters the combustion section.

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CMR 72 30 00 0 AAMO

Compressor Section
Figure 001

LOW PRESSURE COMPRESSOR ASSEMBLY
DESCRIPTION AND OPERATION

1. General

The seven stage low pressure (LP) compressor assembly, shown in the illustration (Ref. Fig. 001), extends from the rear of the air inlet case to the front flange of the compressor intermediate case. The LP compressor assembly comprises a rotor assembly, with a drive shaft extending rearward to the LP turbine assembly, and a compressor case and stator vanes. Each compressor stage of the assembly is formed by a bladed rotor disk together with the ring of stator vanes immediately behind. The stages are numbered from front to rear.

2. Rotor Assembly

The rotor is a bolted assembly supported by two bearings. Bladed disks and spacer rings are assembled between a rotor shaft front and a rotor shaft rear as shown.

The rotor disks have fir-tree form slots equally disposed around their periphery in which the matching roots of the rotor blades engage. Tangs on the roots of the first and second stage blades are trapped by the abutment faces of the spacer rings and disks and retain the blade roots in their slots whereas the blades in the remaining stages are retained with locking keys and tangs. When the engine is static the rotor blades possess some free movement within the fir-tree form slots in the disks. The spacer rings are located between each of the rotor disks and are numbered in relation to the stages they separate e.g., first to second stage spacer. The rotor shaft front carries the inner track of the compressor front bearing which is located in the air inlet case as described in 72-20-00. The rotor shaft rear carries the rear thrust bearing housed in the compressor intermediate case. A bevel gear locates on the external splines of the rotor shaft rear.

Each rotor disk is bolted to the corresponding spacers. The rotor shaft front is bolted to the front face of the first stage rotor disk and the rotor shaft rear to the rear face of the sixth stage rotor disk. Air sealing labyrinths are situated on each of the spacer rings.

3. Case and Vanes

This assembly includes an LP exit guide case which is bolted to the rear flange of the compressor case. Together

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SIGNAL SYSTEM
GENERATING MECHANISM

STATOR VANE

COMPRESSOR CASE

EXIT GUIDE VANE CASE

EXIT GUIDE VANE

ROTOR BLADE

THRUST BEARING

BEVEL GEAR

FRONT BEARING

ROTOR SHAFT
REAR

SPACER

LOCKING CONE

DRIVE SHAFT

ROTOR SHAFT FRONT

INNER FIXING RING

ROTOR DISK

SPHERICAL MOUNTING

LOCKING TUBE

CMR 72 31 00 0 AAM0

LP Compressor Rotor and Case
Figure 001

they contain the seven stages of stator vanes and house the rotor assembly. Stator vanes, stages 1 to 6, are positioned alternately with stages 1 to 6 of the rotor assembly, these stages are housed in grooves in the compressor case. Each groove has diametrically opposed loading slots, stator vanes fitted to these positions are bolted to the case. The inner platforms of the stator vanes are located in fixing rings which provide a seal face for the labyrinths on the rotor spacing
R rings. On engines to SB OL593-72-8690-296 standard (Stages
R 1 to 6) anti-fret liners are installed in the vane fixing
R ring of the stage 1 vane. The seventh stage stator vanes (exit guide vanes), positioned behind the seventh stage rotor blades, are housed in a groove in the exit guide vane case which comprises of two half cases joined axially. A split retaining ring secures the inner platforms of the stator vanes and engages with a sealing ring bolted to the front face of the compressor intermediate inner case.

To facilitate engine internal examination of the compressor rotor blades and stator vanes inspection ports are located in the compressor case and exit guide vane case, at each of the seven stages. The ports are sealed with blanking plugs.

4. Drive Shaft

The drive shaft is in two sections bolted together. Splines at the front end of the drive shaft engage with the internal splines of the rotor shaft rear. A tube unit, housed in the centre of the drive shaft, is used in conjuction with a centre spherical mounting and a locking cone to lock the main drive shaft and rotor shaft rear. The drive shaft incorporates stiffening disks to dampen vibration and the locking tube extends rearward through holes in the disk centres. A shaft twist signal generating mechanism is assembled to the shaft and tube ends.

5. Shaft Twist Signal Generating Mechanism

The generating mechanism is shown in the illustration (Ref. Fig.002) and consists of a helical splined nut between two helically splined guides that are secured to the signal tube and drive shaft respectively. The outer guide engages internal parallel splines on the drive shaft and is retained by a nut. The inner guide, longer than the outer, engages external parallel splines on the signal tube and is secured to the tube by a nut against a shoulder in the bore.

LP COMPRESSOR DRIVE SHAFT

INNER GUIDE RETAINING NUT

CR 31357 00A

LOCKING PIECE

SIGNAL TUBE

GUIDE OUTER

HELICAL NUT

GUIDE INNER

LEFT HAND HELIX

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RIGHT HAND HELIX

SIGNAL SYSTEM LEVER (76-21-00)

Drive Shaft and Signal System
Figure 002

Generating Mechanism

Left-hand helical splines in the outer guide bore and right-hand helical splines externally on the inner guide engage the corresponding internal and external splines of the helical splined nut.

A locking piece engages splines in the bore of the inner guide and locking slots on the guide retaining nut. A retaining nut, screwed into the end of the inner guide and locked by a keywasher, retains the locking piece.

Should the drive shaft twist, it will move circumferentially relative to the locking tube. This displacement acts through the helical splines and moves the helical splined nut rearward. The rear face of the nut contacts the adjacent signal system lever and in travelling rearward operates the system as described in 76-21-00.

6. Operation of the Compressor Assembly

Air enters the first stage of the compressor assembly from the air inlet case in an axial flow path and is accelerated across the first stage rotor blades and leaves the rotor with increased velocity with a helical flow path. The air then enters the first stage stator where the air pressure is increased and its velocity is decreased with a change of direction, to that near axial. The air then enters the rotor of the second stage and subsequent stages of the compressor, with an increase in air pressure produced at each stage, and finally leaves the seventh stage stator to enter the compressor intermediate case.

When the engine is running, the small amount of free movement between the rotor blades and the fir tree form slots in the rotor disk is taken up.

LOW PRESSURE COMPRESSOR ASSEMBLY - INSPECTION/CHECK

1. General

The LP compressor rotor blades and the stage 1 stator vanes can be examined, without dismantling the engine, by the use of optical inspection instruments inserted through ports arranged in pairs at each stage of the LP compressor case, except stage 4 where a single port is provided. The most convenient port in each pair is used. The stages 2 to 6 stator vanes and the exit guide vanes (stage 7 vanes) are not all clearly visible through the inspection ports and damage may be difficult to measure. However, damage acceptance standards are included for these stages of vanes should they be required.

The inspection ports for stages 1 to 6 are sealed with blanking plugs retained by bolts, and the stage 7 inspection ports are sealed with washers and screwed plugs.

Datum blades on engines of S.B. OL.593-72-25 standard can be identified by slots cut in the seventh LP rotor disk. On engines of pre S.B. OL.593-72-25 standard, paint marking may be found to have been used in some instances for datum blade identification.

Access to inspect an installed engine internally is determined by the aircraft nacelle positions and ports on left-hand or right-hand side are selected as accessible.

R Certain types of blade damage can be repaired in-situ,
R without dismantling the engine. For details of in-situ
R blade blending and acceptance limits refer to
R 72-33-00 - Approved Repairs.

B A. Read the following information regarding the use of bore-
B scope equipment. This outlines how these may affect safety
B and their classification relative to **BA** Procedures. The
B precautions listed must be complied with.

B (1) Background and Description

B Borescope inspections of internal engine components
B are frequently carried out. These inspections, when
B conducted with equipment utilising a light source box,
B now require additional precautions to be taken to
B eliminate risk of hazard when used in an environment
B potentially containing combustible gases.

Engines installed or near an aircraft, inside or outside a hangar, fall within the compass of this environment. Uninstalled engines in workshops may also be in a hazardous environment.

These environments are termed "Zone 2" areas but dedicated Zone 2 certification for equipment is not granted by the Regulatory Authority and it is deemed "UNCERTIFIED EQUIPMENT".

A borescope kit comprises of several pieces of equipment but it is only the high intensity light source box which is of concern. Existing boxes (Uncertified Equipment) display a warning notice stating it must not be used in the presence of combustible gases.

Conditions of use of such equipment in a Zone 2 area in strict accordance with procedures (i.e. using gas monitors, etc.) would impose a considerable maintenance/operational burden.

An acceptable relaxation of this situation has been agreed following consultation/borescope demonstration with the Fire Protection Department; although relaxed, adequate safety standards and legal aspects are maintained provided the following precautions are adhered to.

(2) Engines, Installed or near an aircraft

(a) Check aircraft fuel log to ensure it has not uplifted a wide cut fuel (Jet B) during the previous 20 hours of operation.

(b) Aircraft must not be transferring fuel.

(c) Working inside aircraft fuel tanks must not be in progress.

(d) Flammable Liquids with a flash point below 90°F (32°C) must not be used within the Remotely High Risk area - as defined in Section 5.2, EDP-P-FIRE 4.

(e) Spraying or use of Petroleum Based Adhesives must not be permitted.

(f) Liquid Petroleum Gases must not be used within the Remotely High Risk area.

R B (g) If highly flammable liquids are present and
R B "Uncertified Equipment" needs to be used or if
R B any of the above conditions cannot be met, then
R B Section 5.3 of EDP-P-FIRE 4 must be vigilantly
R B followed.

R B (h) Where applicable, Bonding must take place.

R B (3) <u>Engines in Workshops</u>

R B (a) Conditions (2)(d), (2)(e), (2)(f) and (2)(g)
R B apply.

2. <u>Tools and Equipment</u>

Probe	Part of kit PE.35891	PE.15864
Sleeve (retained on probe)...	Part of kit PE.35891	PE.28892
Probe	Part of kit PE.35891	S3S.11561000
Sleeve (retained on probe)...	Part of kit PE.35891	S3S.11562000
Probe	Part of kit PE.35891	PE.15865
Sleeve (retained on probe)...	Part of kit PE.35891	PE.28888
Probe	Part of kit PE.35891	PE.24262
Sleeve (retained on probe)...	Part of kit PE.35891	S3S.11209000
Light transmitting cable ...	Part of kit PE.35891	PE.24099
Probe eye-piece		PE.15969
Light source box		PE.24304
Extractor		PE.17283

3. <u>Terminology for Damage</u>

A. Apply the following definitions to the terms used to describe damage to LP compressor rotor blades and stator vanes:

(1) <u>Bend.</u> A sharp deviation from original line or plane (associated terms, crease, fold, kink, lean).

(2) Crack. Visible partial separation of material which may progress to a complete break (a break is defined as a separation by force into two or more pieces).

(3) Curl. Tips of blades or vanes curled over due to rubbing.

(4) Dent. An indentation usually caused by impact of an object; parent metal is displaced, seldom separated.

(5) Nick. A sharp surface indentation.

(6) Score. Deep scratch.

(7) Scratch. Light, narrow, shallow mark; material is not removed.

(8) Tear. Separation by pulling apart.

4. Examination of LP Compressor Rotor Blades and Stator Vanes

NOTE: Table 601 below details which stages of the L.P. Compressor can be viewed through the inspection ports located around the compressor casing. The Table also establishes whether the trailing edge or leading edge is being viewed.

Inspection Port No.	Number of Port(s) Location	Location of Ports	View Looking Forward	View Looking Rearward
LP 1	1	About bottom C/L of Eng.	T/E-LP1	L/E-LP2
2	1	"	" -LP2	" -LP3
3	1	"	" -LP3	" -LP4
4	1	"	" -LP4	" -LP5

R B

Inspection Port No.	Number of Port(s) Location	Location of Ports	View Looking Forward	View Looking Rearward
5	2	About bottom C/L of Eng. & 9 o/c posn. (view from rear)	" -LP5	" -LP6
6	2		" -LP6	" -LP7
7	2	About 3 & 9 o/c posn.	" -LP7	-

Table 601

A. Prepare Engine for Examination (Ref. Fig.601 and 602).

(1) Open engine bay front doors (Ref.71-00-00, Servicing).

(2) Install LP compressor turning equipment (Ref.72-09-01).

(3) Remove an accessible blanking plug from each port at stages 1 to 6.

(a) Remove bolt securing blanking plug to plug support.

(b) Use extractor and withdraw blanking plug from plug support.

(4) Unscrew blanking plug from stage 7 and remove together with washer.

(5) Prepare and test the optical inspection equipment in accordance with 72-09-03. Select probes, to be used in conjunction with light source box PE.24304 and cable PE.24099, at the specific locations as follows:

<u>CAUTION:</u> DO NOT MOVE LIGHT SOURCE BOX WHILE SWITCHED ON OR WITHIN 30 SECONDS OF SWITCHING OFF. BULB FILAMENT IS NOT SHOCK RESISTANT WHEN HOT.

(a) Stages 1 to 6 probe 11 mm dia. x 19 in. long PE.24262.

(b) Stage 7 probe 8 mm dia. x 19 in. long PE.15864.

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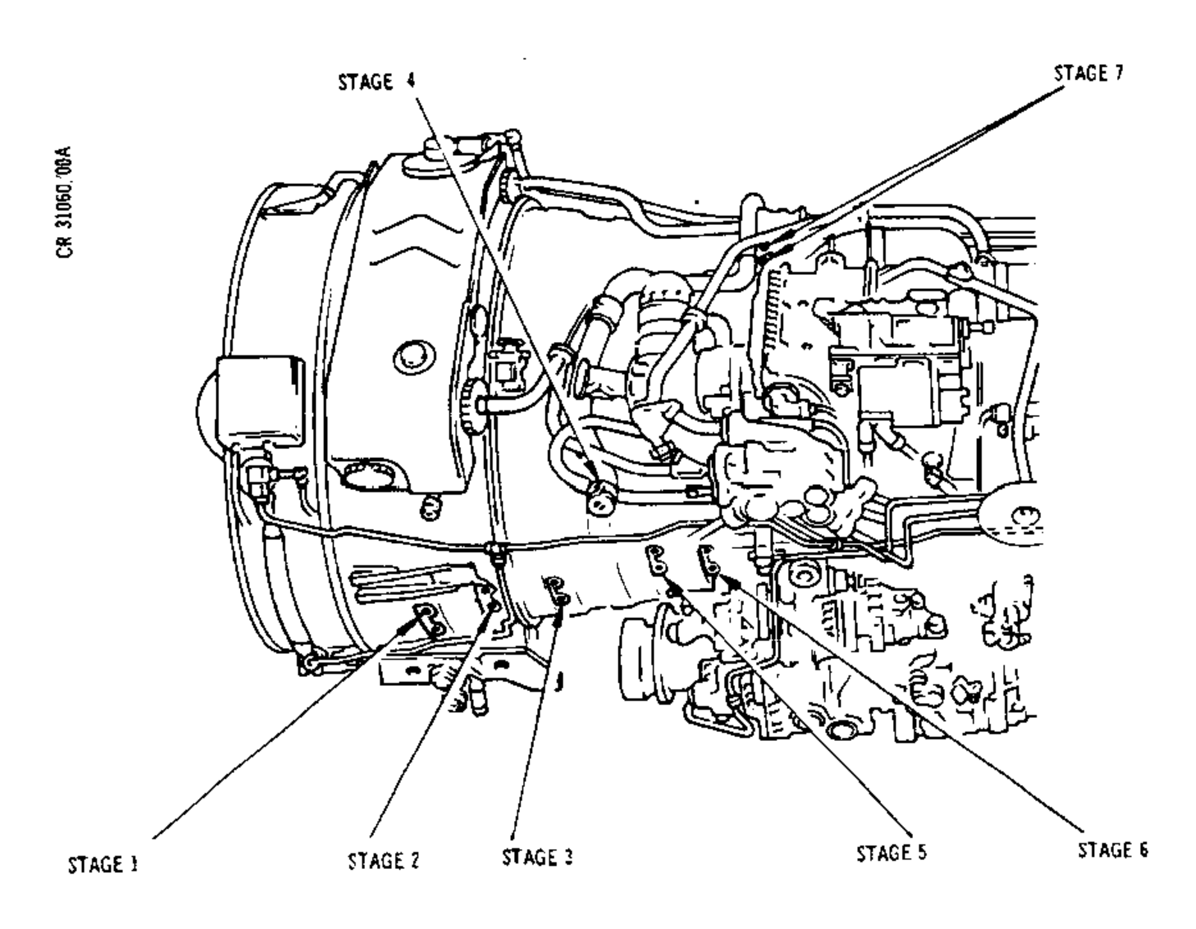
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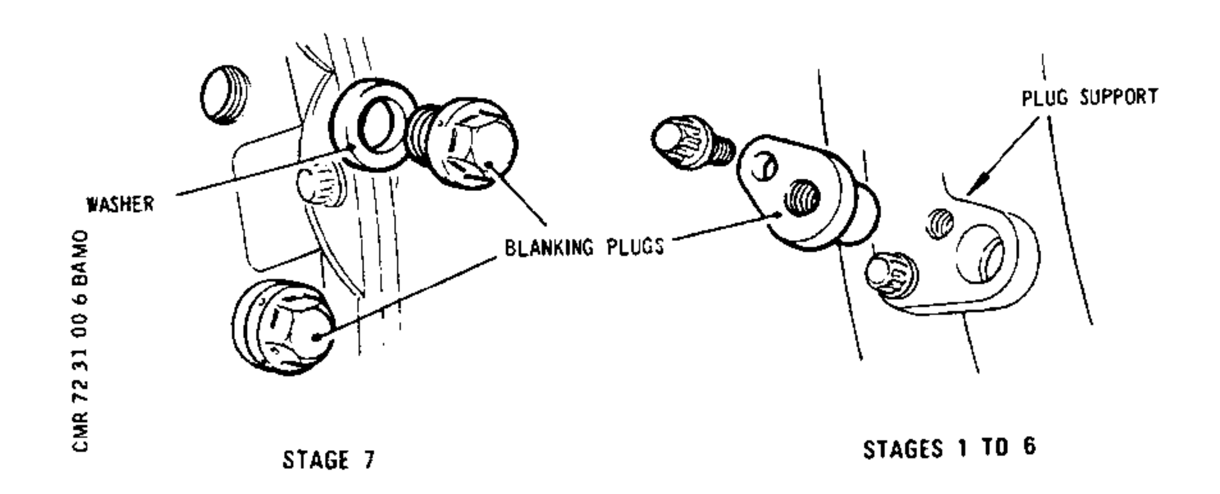
STAGE 7
STAGE 5
FORWARD
STAGE 1
STAGE 6
STAGE 5
STAGE 4
STAGE 3
STAGE 2

BLANKING PLUGS
WASHER
STAGE 7

PLUG SUPPORT
BLANKING PLUG
STAGES 1 TO 6

Right-Hand Side Inspection Port Locations
Figure 601





Left-Hand Side Inspection Port Locations
Figure 602

(c) All stages for blade roots 4,5 mm x 18.7 in. long S3S11561000 or 5,5 mm x 19 in. long PE.15865.

B. Examine the Rotor Blades and Stator Vanes.

(1) Examine the seven stages of rotor blades, stage 1 of the stator vanes and, as far as possible, the remaining stages of stator vanes, as follows:

(a) Insert probe and ensure free penetration.

<u>NOTE:</u> The protective sleeve must be retained on the probe at all times except when removal is essential for insertion of the probe or its effective use when inserted.

(b) Switch on probe illumination and commence
R examination. For quantities of blades per
R stage, refer to Table 606.

(c) Carefully examine the blades for damage by changing the probe position or varying the depth of insertion. Turn the engine as necessary to ensure full coverage of all surfaces to be examined. Switch off illumination before withdrawing probe from its location.

(d) Record extent of any damage found, using the terms given in paragraph 3 and by reference to the illustrations. If a photographic record of the damage is required, use the equipment and procedures detailed in 72-09-04.

(e) Assess the acceptability of any damage by comparison of the examination results with the acceptance standards stated in paragraph 5.

(2) On completion of the compressor examination remove the turning equipment as detailed in 72-09-01.

C. Install Probe Port Blanking Plugs (Ref.Fig.601 and 602).

(1) Apply lubricant B (Ref.70-00-01, Servicing and Storage Materials) to bolts and stage 7 blanking plug and washer.

(2) Install each blanking plug in its respective port at stages 1 to 6.

(a) Ensure that blanking plug and plug support are

clean and damage free.

(b) Carefully insert blanking plug spigot fully into plug support bore.

(c) Secure blanking plug in position on plug support with retaining bolt. Torque-tighten bolt to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(3) Assemble blanking plug to port at stage 7.

(a) Assemble washer to plug and screw into compressor case.

(b) Torque-tighten plug to between 160 and 180 lbf in. (18,1 and 20,3 N.m).

(c) Wire-lock adjacent plugs together.

D. Complete the Inspection.

(1) Close engine bay doors (Ref.71-00-00, Servicing).

5. Acceptance Standards

A. Damage to LP Compressor Rotor Blades and Stage 1 Stator Vanes.

(1) Zone A. No damage is acceptable (Ref. Fig. 603, 605 and 606) (Ref. Fig.607).

CAUTION: THE FOLLOWING DAMAGE IS PERMITTED PROVIDED THE CONDITIONS IN PARA.C. ARE COMPLIED WITH. HEAVIER DAMAGE MAY BE ACCEPTED FOR UP TO 8 FLIGHTS PROVIDED THE DAMAGE CONFORMS TO THE REQUIREMENTS OF PARA.D.

(2) Zone A1 (Stage 1 LP rotor blades only). Accept damaged blades provided (Ref.Fig.603):

(a) Nicks or tears in one edge do not exceed depths (F) of 0.1 in. (2,5 mm) after blending.

R (b) Nicks or tears in both edges do not exceed depths (F) of 0.05 in. (1,3 mm).

(c) Nicks and tears are blended into a smooth

aerodynamic shape and polished to produce a good surface finish.

(d) Blends do not exceed two in number and, if blends interfere, metal is removed to produce a coupled blend.

(e) Scratches/scores are light and polished out.

(3) Zone B. Accept the following damage (Ref. Fig. 603), (Ref. Fig. 605, 606 and 607).

(a) Nicks, tears and surface dents within limits
R given in Table 602.

(b) A dent in one edge up to a lateral displacement of 0.12 in. (3,0 mm).

(c) Light scratches/scores.

(4) Zone C. Accept the following damage (Ref. Fig. 603) (Ref. Fig. 605, 606 and 607).

(a) Nicks, tears and dents within limits given in
R Table 603.

(b) Light scratches/scores.

(c) Tip rubbing with light curling and cracks running from the tip up to 0.25 in. (6,0 mm) long.

(d) Bends in the leading edge of the stage 1 rotor blades, in either direction, provided the deviation at the tip does not exceed 15 degrees.

(5) Throughout the LP compressor, no more than 20 damaged blades are acceptable.

B. Damage to Stages 2 to 6 Stator Vanes and Exit Guide Vanes (Stage 7 Vanes).

(1) Zone A. No damage is acceptable (Ref. Fig.608 and 609).

(2) Zone A1 (Exit guide vanes only). No damage is acceptable (Ref. Fig. 609).

(3) Zone B (Stages 2 to 6 vanes only). Accept the following damage (Ref. Fig. 608).

(a) Nicks, tears and dents within limits given in

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Table 604.

(b) A dent in one edge up to a lateral displacement of 0.12 in. (3,0 mm).

(c) Light scratches/scores.

(4) <u>Zone C</u> . Accept the following damage (Ref. Fig.608 and 609)

(a) Nicks, tears and dents within limits given in Table 605.

(b) Light scratches/scores.

ACCEPTABLE DAMAGE ZONE B	LP COMPRESSOR STAGES ROTOR BLADES 1	2	3	4-7	STATOR VANE 1
DIMENSIONS ARE SHOWN THUS: INCHES (MILLIMETRES)					
Nicks or tears in one edge to depth (E) not exceeding:	0.2 (5,0)	0.12 (3,0)	0.09 (2,3)	0.08 (2,0)	0.1 (2,5)
Nicks or tears in both edges to depth (E) not exceeding:	0.2 (5,0)	0.12 (3,0)	0.09 (2,3)	0.08 (2,0)	0.05 (1,3)
Dents on a surface, which do not deform the surface behind, up to a diameter (G) of:	0.2 (5,0)	0.2. (5,0)	0.12 (3,0)	0.1 (2,5)	0.1 (2,5)
The least amount of undeformed material which					

ACCEPTABLE DAMAGE ZONE B	LP COMPRESSOR STAGES ROTOR BLADES 1	2	3	4-7	STATOR VANE 1
must be between surface dents"	1.0 (25,0)	1.0. (25,0)	0.5 (13,0)	0.5 (13,0)	0.5 (13,0)

LP Compressor Blades/Vane Damage
Table 602

ACCEPTABLE DAMAGE ZONE C	LP COMPRESSOR STAGES ROTOR BLADES 1	2	3-5	6-7	STATOR VANE 1
DIMENSIONS ARE SHOWN THUS: INCHES (MILLIMETRES)					
Nicks or tears in one edge to depth (D) not exceeding:	0.5 (13,0)	0.4 (10,0)	0.3 (8,0)	0.2 (5,0)	0.2 (5,0)
Nicks or tears in both edges to depth (D) not exceeding:	0.5 (13,0)	0.4 (10,0)	0.3 (8,0)	0.2 (5,0)	0.2 (5,0)
A dent in one edge up to a lateral dis-placement of:	0.5 (13,0)	0.25 (6,0)	0.25 (6,0)	0.25 (6,0)	0.25 (6,0)
Dents on a surface, which do not deform the surface behind, up to a diameter (H) of:	0.4 (10,0)	0.4 (10,0)	0.4 (10,0)	0.2 (5,0)	0.2 (5,0)
The least amount of undeformed					

ACCEPTABLE DAMAGE ZONE C	LP COMPRESSOR STAGES ROTOR BLADES 1	2	3-5	6-7	STATOR VANE 1
material which must be between surface dents:	1.0 (25,0)	1.0 (25,0)	0.5 (13,0)	0.5 (13,0)	0.5 (13,0)

LP Compressor Blades/Vane Damage
R Table 603

ACCEPTABLE DAMAGE ZONE B	LP COMPRESSOR STATOR VANES STAGES 2	3-6
DIMENSIONS ARE SHOWN THUS: INCHES (MILLIMETRES)		
Nicks or tears in one edge to depths (E) not exceeding:	0.1 (2,5)	0.06 (1,5)
Nicks or tears in both edges to depths (E) not exceeding:	0.05 (1,3)	0.03 (0,8)
Dents on a surface, which do not deform the surface behind, up to a diameter (G) of:	0.1 (2,5)	0.1 (2,5)
The least amount of undeformed material which must be between surface dents:	0.5 (13,0)	0.3 (8,0)

LP Compressor Stator Vanes Damage
R Table 604

ACCEPTABLE DAMAGE ZONE C	LP COMPRESSOR STATOR VANES STAGES 2	3-6	7
DIMENSIONS ARE SHOWN THUS: INCHES (MILLIMETRES)			
Nicks or tears in one edge to depths (D) not exceeding:	0.2 (5,0)	0.1 (2,5)	0.015 (0,4)
Nicks or tears in both edges to depths (D) not exceeding:	0.1 (2,5)	0.05 (1,3)	0.008 (0,2)
A dent in one edge up to a lateral displacement of:	0.25 (6,0)	0.25 (6,0)	0.12 (3,0)
Dents on a surface, which do not deform the surface behind, up to a diameter (H) of:	0.2 (5,0)	0.1 (2,5)	0.1 (2,5)
The least amount of undeformed material which must be between surface dents:	0.5 (13,0)	0.3 (8,0)	0.5 (13,0)

LP Compressor Stator Vanes Damage
R Table 605

C. Conditions Applicable to the Acceptance Standards Given in Para.A. for Stage 1 LP Rotor Blades.

R B NOTE: Damage which falls outside that stated in paragraph
R B A and B and within paragraph C and D must be referr-
R B ed to Power Unit Engineering so that monitoring
R B requirements may be determined and called up by E.I.

(1) Certain blades are susceptible to periods of vibration which may exploit damage marks/blends. Therefore comply with the following conditions:

(a) Damage in Zone A1 of Stage 1 LP rotor blades which had been blended out, must be dye penetrant inspected at intervals not exceeding 25 hours of engine flight time running. If cracks do not appear beyond 100 hours of flight time with such blending, further dye penetrant inspections are considered unnecessary.

(b) Damage in Zones B and C of Stage 1 LP rotor blades must be blended to the "In-situ Blending Standard", defined in para.E., within eight flights of the damage occurring.

D. Damage outside the Acceptance Standards for LP Rotor Blades and Stator Vanes
(Ref.Fig.603, 605 and 606)
(Ref.Fig.607, 608 and 609)

(1) If damage occurs in Zones B and C, (where applicable), within twice the stated acceptable limits for E, G, D and H, (where applicable), a maximum of 8 flights may be carried out before the affected vanes/blades must be renewed.

R

E. Conclusion.

(1) Rolls-Royce (1971) Limited/SNECMA reserve the right to amend all or any part of the acceptance standards, stated in paragraphs A, B, C and D, as engine operational experience, with damaged blades, is gained.

LP COMPRESSOR STAGE	QUANTITY PER STAGE
1	19
2	25
3	33
4	34
5	33
6	29
7	33

LP Compressor Blades
Table 606

RB 6. Examination of Compressor Stage 2 Blade Roots

RB A. General

RB Carry out a borescope examination of the front and rear
RB face of the LP2 blade roots for cracks using the following
RB procedure.

RB B. Equipment Required

RB	Borescope probe	C080-048-090-50
RB	Light source box	-
RB	Olympus KMI video equipment	-

C. Procedure (Ref. Fig. 610)

(1) Remove the borescope hole blanking plugs at Stage 1 and 2 stator positions as per 72-31-00, Adjustment/Check.

(2) Insert the borescope through the Stage 1 inspection port for the front face of the blade root and the Stage 2 inspection port for the rear face. Guide the probe so that it passes carefully between the spacer and LP2 disc as shown in Fig. 610.

(3) Attach the video camera to the probe. Position the probe to give a suitable image of the area shown in Fig. 610. As the disc is rotated slowly, the area scanned by the video is to be recorded.

(4) Looking rearwards onto the forward face of the LP2 blade root examine the image as each root passes by for cracks. If a potential crack is spotted, stop the recording, reposition the probe to obtain a close up view from various angles, record each view whilst the probe is static only. If the area under examination is still open to interpretation contact Tech Services Propulsion Engineering.

(5) Repeat the inspection on the rear face of the LP2 blade root.

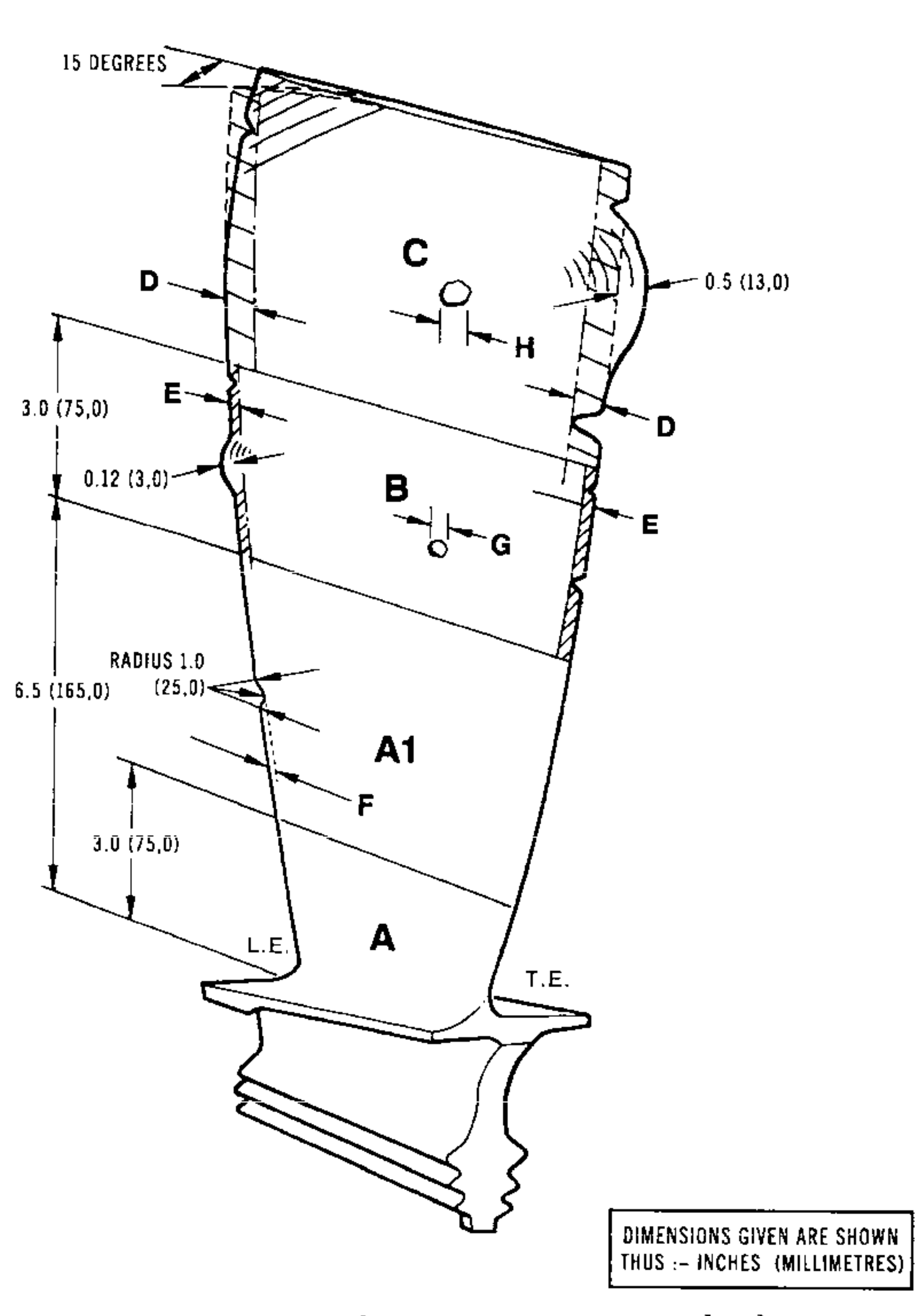
(6) Pass the video tape to Propulsion Engineering for review should no defects be found. (Clearance of the tape from Propulsion Engineering is not required).

(7) If no cracks are observed, replace the removed borescope plugs in accordance with 72-31-00, Inspection/Check, para. 4.C. to para. 4.D.

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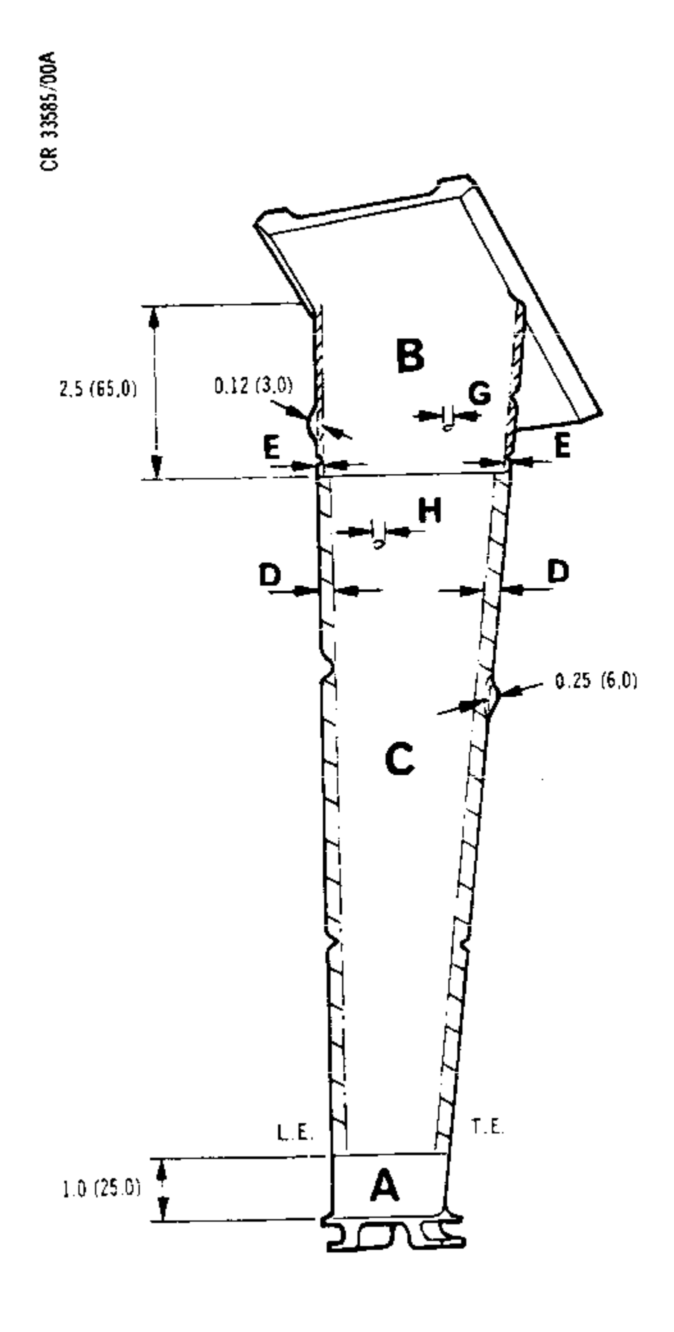
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R
R
R



Stage 1 LP Rotor Blade - Acceptance Standards
Figure 603

R Figure 604 Deleted



CMR 72 31 00 6 EAMO

Stage 1 LP Stator Vane - Acceptance Standards
Figure 605

CR 33586/00A

L.E.
T.E.
H
C
0.25 (6.0)
D
D
3.5 (90.0)
G
B
0.12 (3.0)
E
E
4.5 (110.0)
A

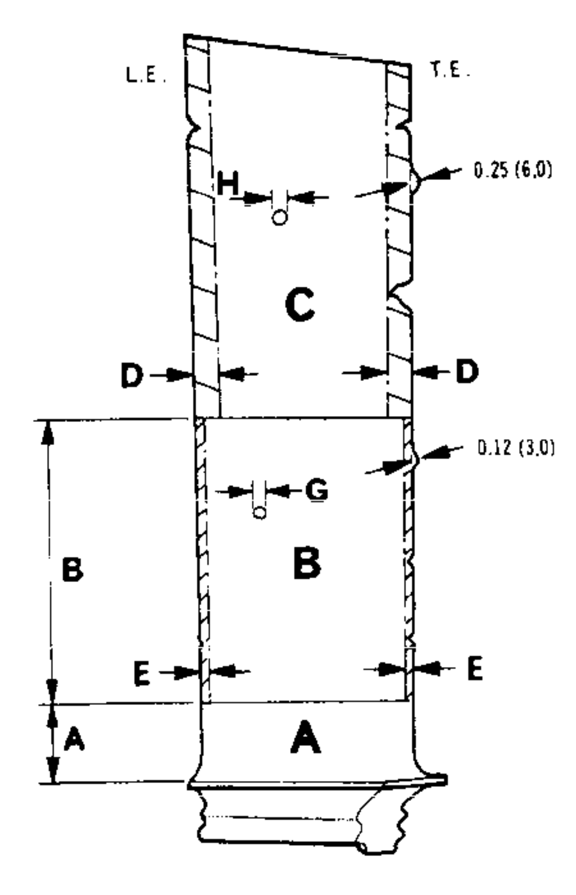
DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)

CMR 72 31 00 6 FAMO

Stage 2 LP Rotor Blade - Acceptance Standards
Figure 606

DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)

CR 33587 00A



STAGE	3	4	5	6	7
DIMENSION **A**	2.5 (60,0)	1.0 (25,0)	1.0 (25,0)	1.0 (25,0)	1.0 (25,0)
DIMENSION **B**	3.0 (75,0)	3.0 (75,0)	2.5 (60,0)	2.5 (60,0)	2.0 (50,0)

CMR 72 31 00 6 GAMO

Stages 3 to 7 LP Rotor Blades - Acceptance Standards
Figure 607

CR 33919/00A

G

B

0.120 (3,0)

B

E

E

H

TE

LE

C

DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)

0.250 (6,0)

D

D

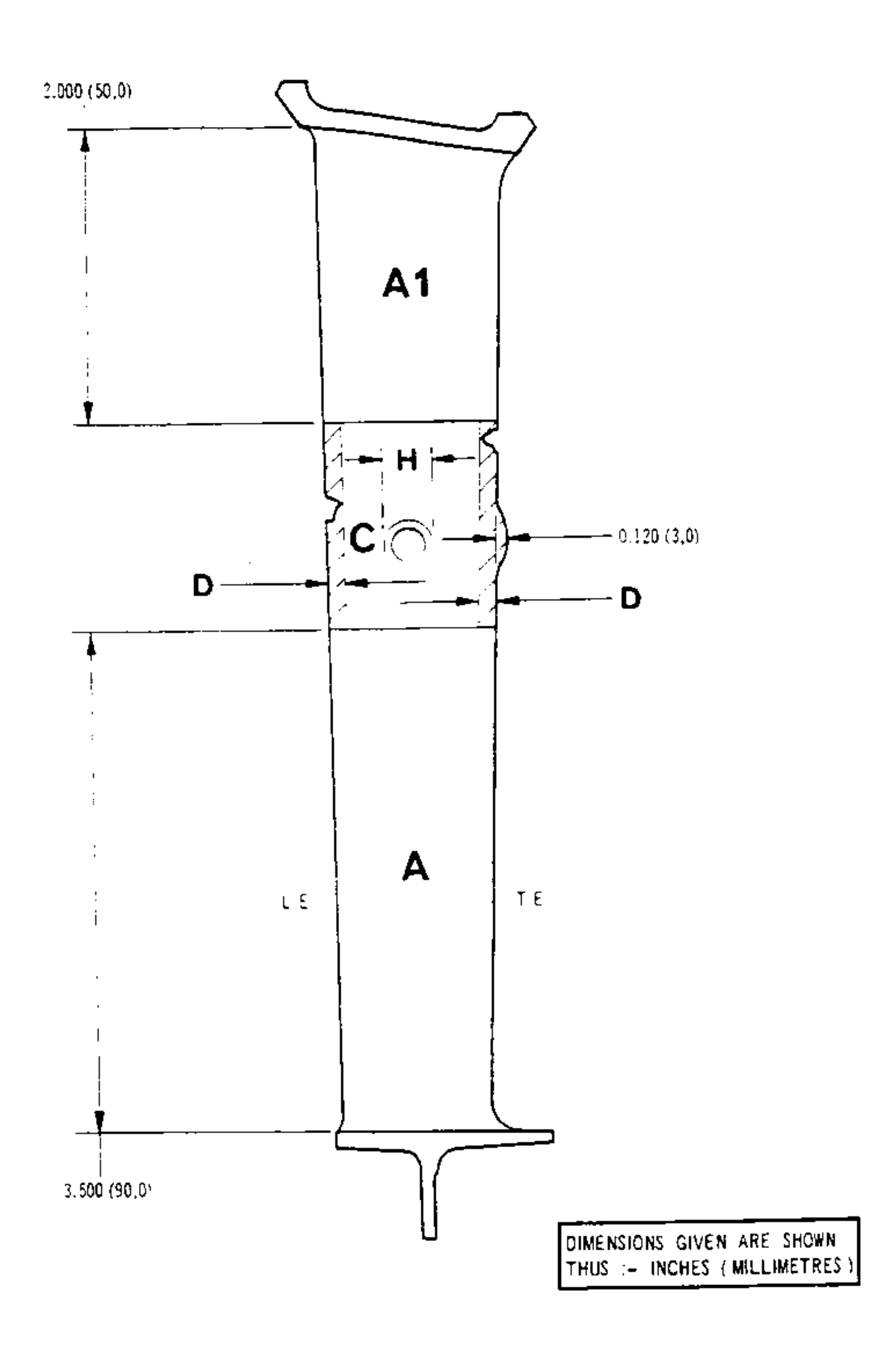
A

A

CMR 72 31 00 6 HAM0

STAGE	2	3	4	5	6
DIMENSION **A**	1.000 (25,0)	4.000 (100,0)	4.500 (110,0)	4.000 (100,0)	3.500 (90,0)
DIMENSION **B**	2.000 (50,0)	3.000 (75,0)	2.500 (60,0)	2.000 (50,0)	2.000 (50,0)

Stages 2 to 6 LP Stator Vanes - Acceptance Standards
Figure 608



LP Compressor Exit Guide Vanes (Stage 7) -
Acceptance Standards
Figure 609

7. Examination of Compressor Stage 5 Blade Roots

A. GENERAL

Carry out a borescope examination of both sides of the LP 5 blade root for cracks using the following procedure.

B. EQUIPMENT REQUIRED

EQUIPMENT REQUIRED	BA Stores Code
5,5 mm x 19" borescope	HZAE 1379
Fibre light guide	HZAC 1753 (Part of Kit HWAK 1043)
Light source box	GEEB 0308
200′ Extension Lead	GWAC 1292

C. PROCEDURE (Ref.Fig.610)

(1) Remove the borescope plugs from the LP compressor stage 4 and 5 borescope ports as per MM 72-31-00 P.602 - 604.

(2) Insert the borescope through the stage 4 port so that it passes between the St.4 stator and St.5 blade inner platforms as shown in fig.610.

(3) Looking rearward examine the front face of the stage 5 blade firtree root serrations in the disc for cracks.

NOTE: There are three serrations per blade and 33 blades in the disc.

(4) Repeat for the rear face of the blade using the stage 5 port and looking forward this time.

NOTE: It will not be possible to insert an 8 mm dia. borescope between stator and blade inner platforms.

(5) If any cracks in the blade roots are observed during this inspection, notify Power Unit Engineering before proceeding further.

A

TYPICAL CRACK ACROSS
FWD AND AFT FACE

LP COMPRESSOR
CASING

BORESCOPE
C080-048-090-50

STATOR AND BLADE
INNER PLATFORMS

STATOR
BLADE

5.5 mm BORESCOPE

EXIT GUIDE
VANE CASING

STAGE 2

STAGE 5

ROTOR
BLADE

A

LP ACCESSORY

FRONT STUB
SHAFT

DRIVE
BEVEL

REAR STUB
SHAFT

ROTOR DISC

SPACER RING

STATOR
SUPPORT
RING

CMB 72 31 00 6 AUM0 00

PRINTED IN ENGLAND

RB

Low Pressure Compressor Assembly
Figure 610

(6) If no cracks are observed, replace borescope plugs IAW MM 72-31-00 Pages 606 - 607.

RB 8. Intrascope Inspection

A. General.

The following British Airways procedure and equipment is given to enable an intrascope inspection to be made of internal engine components.

B. Equipment and Materials.

(1) Intrascope Kit BAOD code HWAK 1043 with carrying case containing:

(a) Fibrelight guide cable BAOD code HZAC 1753.

(b) Lateral view Endoprobe with focusing 8 mm dia. x 19 ins. long BAOD code HZAE 1279.

(c) Right angle eyepiece for use with lateral view Endoprobe BAOD code HZAM 0409.

(d) Forward view Endoprobe with fixed focus 8 mm dia. x 13 ins. long.

(e) Spare bulb for the light source box BAOD code LELP 1752.

(2) Light source box (not in carrying case) BAOD code GEEB 0308 for use with the two endoprobes.

(3) Endoprobe 5.5 mm dia. x 19 ins. long (with box) BAOD code HZAE 1379 for inspecting HP compressor blade roots.

NOTE: With the 5.5 mm dia. probe use light source box code GEEB 0308 and fibrelight guide cable code.

(4) Extractor pt. no. PE 17283, BAOD code HMKE 1049 (used to remove certain intrascope ports).

(5) Extension lead BAOD code GWAC 1292 (used to take a power supply from a/c vacuum cleaner sockets).

(6) Probe "Hot Light" quartz iodine 42 inches long BAOD code HZAP 2075.

C. Inspection.

NOTE: Refer to chapter 72-33-00 page block 601 for H.P. Compressor inspection port locations.

(1) Intrascope inspection of internal engine components.

(a) Use of equipment.

(a1)	LP & HP Compressor Stages 1 - 7 Blade Aerofoil L/E or T/E	Forward view endoprobe 8 mm dia. x 13" long or lateral view endoprobe 8 mm dia. x 19" long - See Note
(a2)	LP & HP Compressor Stages 1 - 7 Blade Tips	Lateral view endoprobe 8 mm dia. x 19" long
(a3)	HP Compressor Stage 1 Blade Roots	Endoprobe 5.5 mm dia. x 19" long

NOTE 1: Use of either the forward view endoprobe or the lateral view endoprobe solely depends on which probe the operator finds most convenient to use for the various inspections.

NOTE 2: The lateral view endoprobe with focusing can be used in conjunction with the right angle eyepiece if so desired.

D. Power Supplies.

(1) The light source box code GEEB 0308 can be operated on either 240V. AC or 110V AC. The voltage selector is inside the box. To remove the cover remove the knurled screw on the top of the box and unscrew the two forward screws on the side of the box.

(2) Extension lead code GWAC 1292 can be plugged into the Hoover sockets located near the L/H centre toilet at floor level. This is 110V. AC. Feed the cable out through the forward passenger door to the ground.

R B

LOW PRESSURE COMPRESSOR ASSEMBLY
APPROVED REPAIRS

1. General

The instructions given in this chapter deal with the in-situ blending and polishing of damaged Stage 1-7 LP Compressor Rotor Blades.

In-situ blending and polishing of the Stage 1 blade can be carried out using standard hand tools.

In-situ blending and polishing of Stage 2 to 7 blades is achieved through the inspection ports on the LP Compressor Casing using the blending kit.

It is recommended that two skilled operatives be used to assess the extent of blending required before using the procedures
R contained in this chapter. It is recommended that the Blade
R Blending Training Aid is used to maintain operatives blending
R proficiency, using scrapped blades (Ref.Para.3.).

The debris produced by this process will not normally be harmful to the engine. However, if large pieces of blade become detached during the procedure, contact the Olympus 593 Project Office, Rolls-Royce plc, Filton, Bristol.

2. Tools and Equipment

DESCRIPTION	PART NO.
Blade Blending Kit ... ... Comprising:	S3S.20282000
Blending Tool	5.08036.002
Borescope	6.04044.072
Power Unit...	5.00024.95
Power Unit Supply Cable (13 A Plug).. ...	72325.178
Power Unit Supply Cable (16 A Plug).. ...	72325.179
Tool Set (Box 1) (Ref. Table 801)	5.00301.123
Tool Set (Box 2) (Ref. Table 801)	5.00301.223
Tool Set Measurement (Box 3)...	5.00301.134

BS00015349/1

LPC STAGE	LENGTH (MM)	CARBIDE ROUNDED CONE FORM 1	CARBIDE BALL FORM 3	DIAMOND ROUNDED CONE FORM 10	DIAMOND BALL FORM 8	POLISHER DIAMOND BALL FORM 4
7LE	45	5.00345.001	5.00345.003	5.00345.010	5.00345.008	5.00345.004
3LE, 4TE	50	5.00350.001	5.00350.003	5.00350.010	5.00150.008	5.00350.004
1TE,2LE,2TE,3LE,5TE	55	5.00355.001	5.00355.003	5.00355.010	5.00355.008	5.00355.004
3TE	60	5.00360.001	5.00360.003	5.00360.010	5.00360.008	5.00360.004
1TE, 6LE	65	5.00365.001	5.00365.003	5.00365.010	5.00365.008	5.00365.004

HPC STAGE	LENGTH (MM)	CARBIDE ROUNDED CONE FORM 1	CARBIDE BALL FORM 3	DIAMOND ROUNDED CONE FORM 10	DIAMOND BALL FORM 8	POLISHER DIAMOND BALL FORM 4
5TE,6LE	20	5.00320.001	5.00320.003	5.00320.010	5.00120.008	5.00320.004
4LE,5TE,7TE,(LPC5LE)	25	5.00325.001	5.00325.003	5.00325.010	5.00125.008	5.00325.004
1TE,2LE,2TE,3LE,3TE, 4LE,5LE (LPC5LE)	30	5.00330.001	5.00330.003	5.00330.010	5.00330.008	5.00330.004
1TE,3TE,4TE, (LPC3LE) 4LE,4TE,5TE,6TE,7LE,7TE	35	5.00335.001	5.00335.003	5.00335.010	5.00335.008	5.00335.004
2LE	40	5.00340.001	5.00340.003	5.00340.010	5.00340.008	5.00340.004

Tool Selection
Figure 801

DESCRIPTION	PART NO.
R Blade Blending Training Aid	S3S.20592000
Adapter and Immobiliser	S3S.20255000
Equipment Reference Manuals:	
General Operating and Troubleshooting ...	GA-T023
Olympus Mk.593-610 Specific	BB-T023-5

R 3. Blade Blending Training Aid

R A. General

R (1) This equipment provides a means of maintaining
R proficiency in the techniques necessary to perform
R in-situ blade blending.

R (2) The equipment comprises a box housing a simulation of
R a 3 blade section (stages 2, 3 and 4) of the HP
R Compressor Rotor. These stages provide blade samples
R of varying section and both materials used in the
R compressor, (titanium and nimonic 90).

R (3) The rotor block is fitted with a tilt mechanism
R enabling the rotor blades to be moved relative to the
R stator vanes. This enables the user to achieve the
R optimum position for the selected blend.

R (4) Calibration blades are included in a separate
R compartment, and provide engraved damage marks
R equivalent to the maximum allowable per zone, per
R stage.

R B. Equipment Operation

R (1) Load calibration blade(s) into position and tighten
R clamp block to secure.

R (2) Close box and place in a position to best suit the
R operator.

R (3) Assess damage using blending tool fitted with
R comparitor head.

R (4) Remove calibration blade(s).

R (5) Load 'scrap' blade(s) into position, and tighten clamp block to secure.

R (6) Assess damage using blending tool fitted with comparitor head.

R (7) Record details of damage.

R (8) Replace with cutting tools and blend defect until removed.

R (9) Replace cutting tool with comparitor head and reassess size of blended defect.

R (10) Open box, remove blade and review acceptability of blend against criteria as detailed in repair procedure.

R 4. Terminology for Damage

A. Apply the following definitions to the terms used to describe damage to the LP compressor rotor blades:

(1) Bend. A sharp deviation from original line or plane (associated terms, crease, fold, kink, lean).

(2) Crack. Visible partial separation of material which may progress to a complete break (a break is defined as a separation by force into two or more pieces).

(3) Curl. Tips of blades or vanes curled over due to rubbing.

(4) Dent. An indentation usually caused by impact of an object. Parent metal is displaced, seldom separated.

(5) Nick. A sharp surface indentation.

(6) Score. Deep scratch.

(7) Scratch. Light, narrow, shallow mark; material is not removed.

(8) Tear. Separation by pulling apart.

R 5. Repair Limitations

A. In-situ Blending and polishing repairs are only possible on the blade areas given in Table 801 and to the limits given in Figures 807, 808, 809, 810, 811, 812 and 813.

LP Compressor Rotor Stage	Area	Repair Possible
1	Leading Edge	HAND TOOLS ONLY
	Trailing Edge	HAND TOOLS ONLY
2	Leading Edge	YES
	Trailing Edge	YES
3	Leading Edge	YES
	Trailing Edge	YES
4	Leading Edge	YES
	Trailing Edge	YES
5	Leading Edge	YES
	Trailing Edge	YES
6	Leading Edge	YES
	Trailing Edge	YES
7	Leading Edge	YES
	Trailing Edge	YES

Table 801 - LP Compressor Rotor Blade Repair Areas

B. Blades with dents, which deform the opposite surface of the blade, are not acceptable for blending. Reject blades with this form of damage.

C. Blends must exceed the depth of damage by 20 per cent.

D. Blends must not run out into Zone X.

E. Only blends to rectify minor damage to a maximum depth of 0.010 in (0,25 mm) are allowed in Zone X.

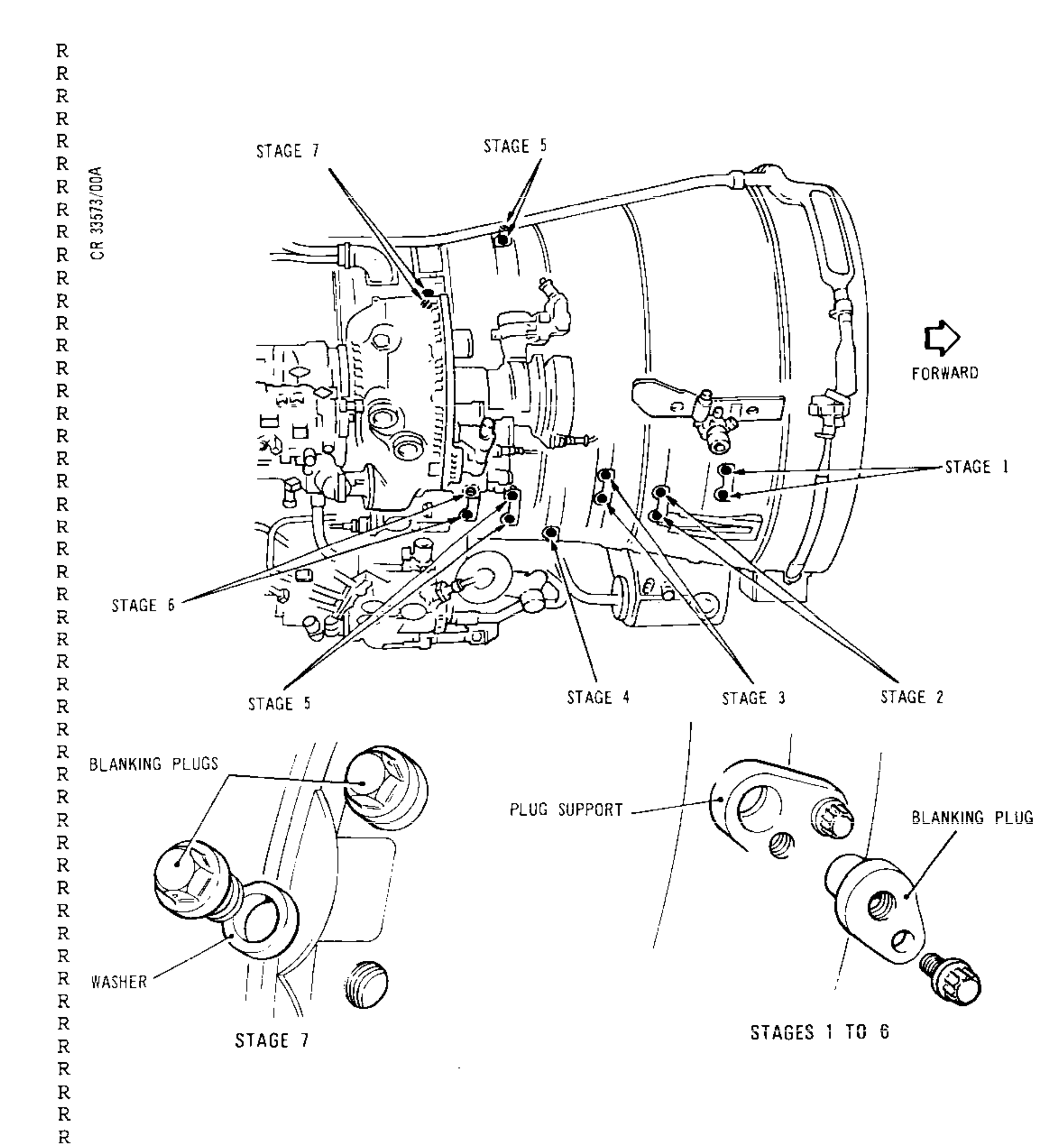
F. Due to limited access through the inspection ports on Stages 2-7, it is not possible to carry out blending to the tip of the blades. Damage should therefore be assessed prior to commencing any repair, to ensure that tool access is sufficient to allow full blend radii to be achieved without creating a 'hooked' aerofoil (Ref. Fig.813).

R 6. <u>Prepare Engine for Repair</u>

A. Open engine bay front doors (Ref. 71-00-00, Servicing).

B. Install LP compressor turning equipment (Ref. 72-09-01, Standard Practices).

C. Remove or loosen engine-dressing items as necessary to gain access to the blanking plugs on the LP compressor casing.

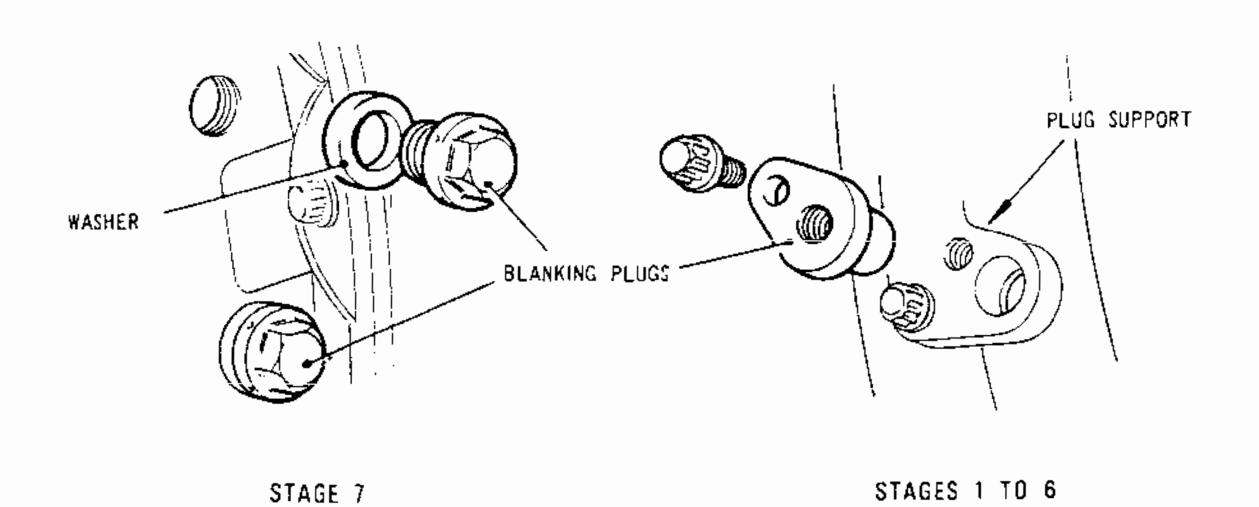


LP Compressor Casing - Right-Hand Side Inspection Port Locations
Figure 802

CR 33574/00A

STAGE 4
STAGE 7

STAGE 1
STAGE 2
STAGE 3
STAGE 5
STAGE



LP Compressor Casing - Left-Hand Side Inspection Port Locations
Figure 803

D. Remove the appropriate blanking plug from the LP compressor casing (Ref. Fig. 802 and 803).

6. In-Situ Blade Blending Procedures

A. In-situ blending of Stage 1 LP Compressor Rotor Blades using standard hand-tools (Ref. Fig. 807).

<u>CAUTION:</u> IF MECHANICAL BLENDING METHODS ARE USED, ENSURE THAT BLADES ARE NOT OVERHEATED.

(1) Assess the extent and depth of the damaged blade using the comparator (Ref. Fig.804).

<u>NOTE:</u> This procedure should be carried out by two separate skilled operatives to ensure an accurate assessment.

(2) Carry out a crack detection check of all damaged areas before and after blending, using Ardrox 996P in accordance with the manufacturers instructions and safety precautions.

(3) For blends carried out on edge only, the depths D and E must not exceed 0.600 in. (15,0 mm) and 0.250 in. (6,0 mm) respectively.

(4) For blends carried out on both edges, the depths D and E must not exceed 0.300 in. (8,0 mm) and 0.120 in. (3,0 mm) respectively.

(5) If blends interfere, metal must be removed to produce a coupled blend.

(6) A maximum of two blends or one coupled blend per zone is permitted.

(7) Torn, rough or scored edges must be blended to a depth 20 per cent greater than the damage depth.

(8) Blends must be smoothly profiled into the aerofoil shape. Leading and trailing edges should be blended into a radius and should not leave a knife-edge.

(9) Defective areas and blends to be polished to produce a good surface finish.

B. In-situ blending of Stage 2-7 LP Rotor Blades using Blade Blending Kit (Ref. Figs. 804, 805, 806, 807, 808, 809, 810, 811, 812 and 813).

(1) General tool selection and operation

(a) Select the appropriate cutter according to which stage and area of blade requires blending (Ref. Fig. 801).

NOTE: The tools are listed as a guide only, operators may choose to use a different length cutter or polisher to that specified for a certain stage.

(b) Information regarding the sizes and type of blade material are given in Table 802 - LP Compressor Rotor Blade Information, to further assist in the cutter selection.

(c) The blade blending kit may be used on its own or in conjunction with a CCD camera attachment and TV monitor.

DESCRIPTION	MATERIAL	QTY	MAX WIDTH		AEROFOIL LENGTH	
			*INCH	MM	INCH	MM
STAGE 1	Titanium	19	6.50	165,0	15.00	381,0
STAGE 2	Titanium	25	4.70	120,0	13.00	330,0
STAGE 3	Titanium	33	3.30	83,0	11.00	279,0
STAGE 4	Titanium	34	3.20	81,0	10.00	254,0
STAGE 5	Titanium	33	3.20	81,0	9.00	229,0
STAGE 6	Titanium	29	3.40	87,0	8.00	203,0
STAGE 7	Titanium	33	2.90	73,0	7.50	191,0

* ROUNDED FIGURES

Table 802 - LP Compressor Rotor Blade Information

(d) The comparator is installed in the tool head and used in place of a cutter to inspect and assess the extent of the damaged blades (Ref. Fig.804).

(e) It is recommended that a large diameter borescope is used periodically instead of the blending kit borescope for inspection of the blend, this will enable a clearer view of the blend.

(2) Procedure (Ref. Figs. 804, 805 and 806)

CAUTION: THE LP COMPRESSOR ROTOR MUST BE LOCKED BEFORE ATTEMPTING ANY MEASUREMENT OR REPAIRS.

(a) Lock the LP compressor rotor in the required position using the adapter and immobiliser.
Due to the geometry of the LP blades, it may be necessary to unlock, rotate abd re-lock the LP compressor rotor to obtain the position for blending (Ref. Fig. 805).

(b) Assess the extent and depth of the damaged blade using the comparator (Ref. Fig. 804).

NOTE: This procedure should be carried out by two separate skilled operatives to ensure an accurate assessment.

(c) Assess the suitability for repair in accordance with paras. 7 and 8.

CAUTION: THE CUTTER IS LOCATED IN THE HEAD USING A TWIN SCREW THREAD. BEFORE USING THE BLADE BLENDING TOOL, ENSURE THAT THE CUTTER IS LOCATED CORRECTLY IN THE HEAD. THERE SHOULD BE NO GAP BETWEEN THE CUTTER SHANK AND THE TOOL HEAD.

CAUTION: BEFORE USE, ENSURE THAT THE DIRECTION OF CUTTER ROTATION IS CORRECT. WHEN VIEWED FROM ABOVE, THE TOOL MUST ROTATE ANTI-CLOCKWISE.

CAUTION: BEFORE USE, ENSURE THAT THE BORESCOPE, IS CORRECTLY LOCKED IN THE TOOL.

(d) Select and install the appropriate cutter in the tool head (Ref. para. 6.B.(1)).

(e) Straighten the tool head and insert the blending scope through the inspection port.

CAUTION: DO NOT SWITCH THE CUTTER ON BEFORE ARTICULATING THE TOOL HEAD. THIS WILL RESULT IN THE DISENGAGEMENT OF THE CUTTER DRIVE BELT.

(f) Articulate the tool head through approximately 90 degrees, visually check the cutter position in relation to the blade, then switch on and select a high-speed setting.

NOTE: The operating range of the tool is between 80 - 100 degrees. The tool will not operate when the tool head is articulated outside of this range.

CAUTION: DURING BLENDING OPERATIONS, CARE MUST BE TAKEN TO AVOID TOOL HEAD AND SHANK CONTACT WITH ADJACENT BLADES.

(g) Carry out roughing cuts to remove damage.

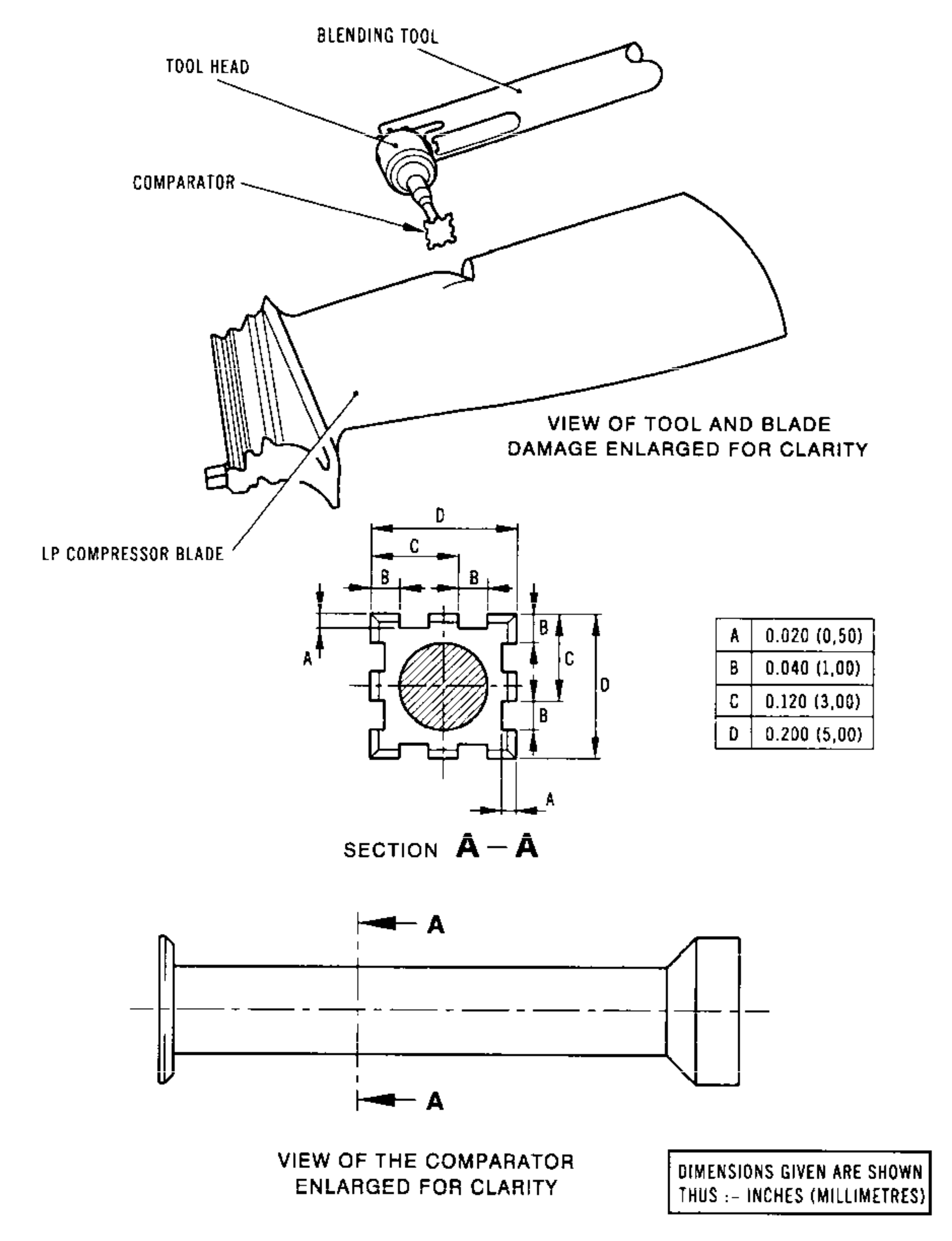
NOTE: If too much pressure is applied to the tool, the cutter may stop due to belt slippage. If this happens carefully release the pressure and resume cutting.

(h) Switch off the cutter, articulate the tool head straight and withdraw the blending scope from the engine.

(i) Remove the cutter from the tool head. Select and install a radius cutter (Ref. para. 6.B.(1)).

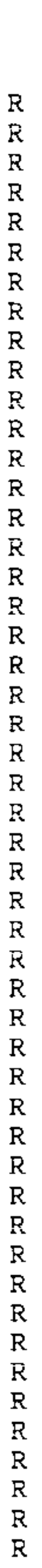
(j) Straighten the tool head and insert the blending scope through the inspection port.

CAUTION: DO NOT SWITCH THE CUTTER ON BEFORE ARTICULATING THE TOOL HEAD. THIS WILL RESULT IN THE LOSS OF THE CUTTER DRIVE BELT.



A	0.020 (0,50)
B	0.040 (1,00)
C	0.120 (3,00)
D	0.200 (5,00)

R Measurement and assessment of Damaged Blades
R Figure 804



BS0001535I/1

LOCKING THUMBNUT

EXTENSION BAR

UNIVERSAL JOINT

A

B

ADAPTER AND
IMMOBILISER
(TOOL No. 3147)

WARNING

TORQUE ADAPTER

TORQUE WRENCH

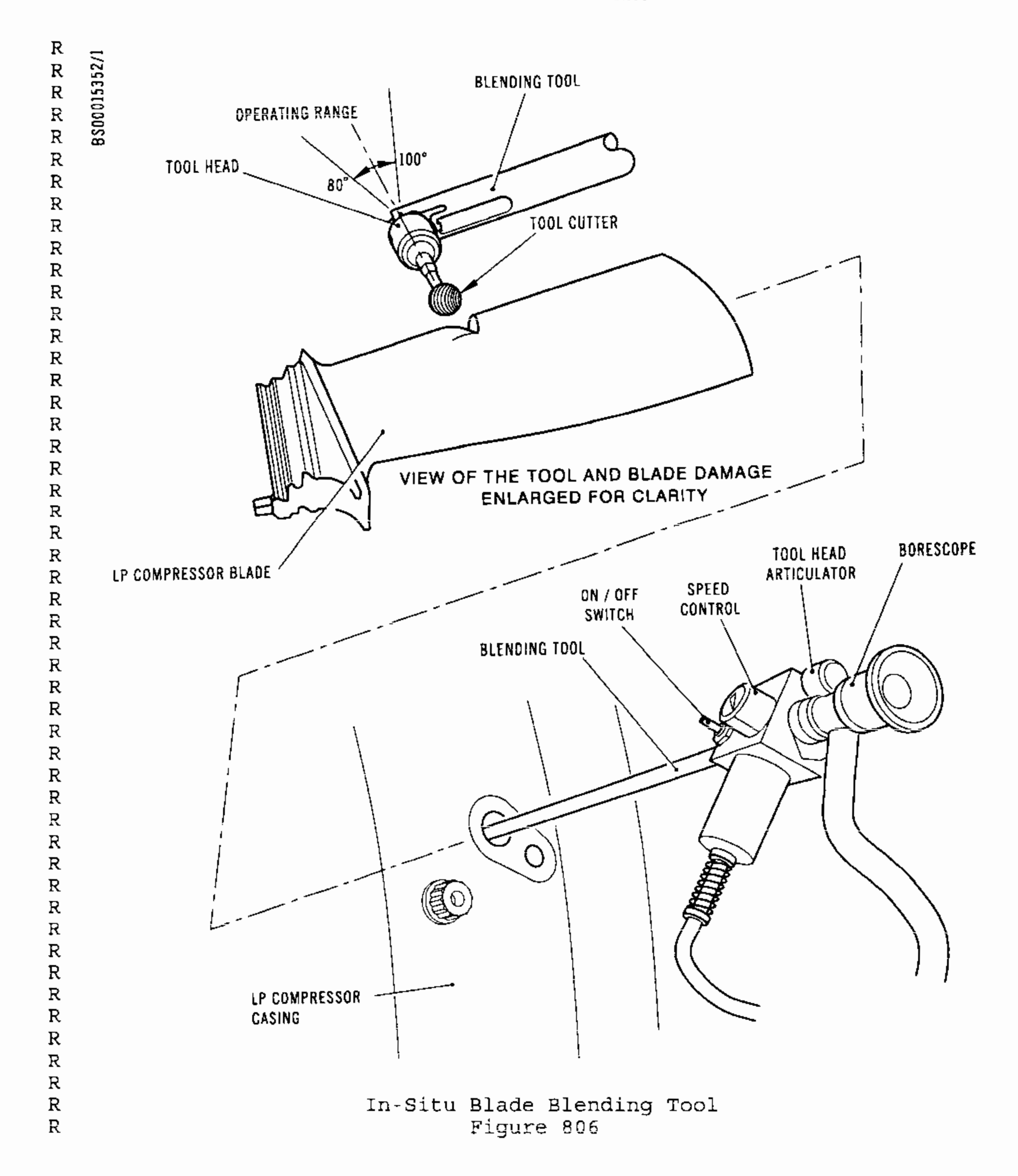
A

PULSE PROBE AND HOUSING
LP SHAFT TURNING POINT

B

RIGHT HAND GEARBOX
HP SHAFT TURNING POINT

Locking the LP Compressor Rotor
Figure 805



In-Situ Blade Blending Tool
Figure 806

(k) Articulate the tool head through approximately 90 degrees, visually check the cutter position in relation to the blade, then switch on and select a high-speed setting.

<u>NOTE:</u> The operating range of the tool is between 80 - 100 degrees. The tool will not operate when the tool head is articulated outside this range.

<u>CAUTION:</u> DURING BLENDING OPERATIONS, CARE MUST BE TAKEN TO AVOID TOOL HEAD AND SHANK CONTACT WITH ADJACENT BLADES.

(l) Carry out radius cutting.

<u>NOTE:</u> If too much pressure is applied to the tool, the cutter may stop due to belt slippage. If this happens carefully release the pressure and resume cutting.

(m) Switch off the cutter, articulate the tool head straight and withdraw the blending scope from the engine.

(n) Remove the cutter from the tool head. Select and install a polisher (Ref. para. 6.B.(1)).

(o) Straighten the tool head and insert the blending scope through the inspection port.

<u>CAUTION:</u> DO NOT SWITCH THE CUTTER ON BEFORE ARTICULATING THE TOOL HEAD. THIS WILL RESULT IN THE LOSS OF THE CUTTER DRIVE BELT.

(p) Articulate the tool head through approximately 90 degrees, visually check the cutter position in relation to the blade, then switch on and select a high-speed setting.

<u>NOTE:</u> The operating range of the tool is between 80 - 100 degrees. The tool will not operate when the tool head is articulated outside of this range.

CAUTION: DURING BLENDING OPERATIONS, CARE MUST BE TAKEN TO AVOID TOOL HEAD AND SHANK CONTACT WITH ADJACENT BLADES.

(q) Carry out finish polishing.

NOTE: If too much pressure is applied to the tool, the cutter may stop due to belt slippage. If this happens carefully release the pressure and resume polishing.

(r) Switch off the polisher, articulate the tool head straight and withdraw the blending scope from the engine.

(s) Remove the polisher from the tool head. Install comparator.

(t) Inspect and measure the blend using the comparator (Ref. Fig.804).

R (u) Record details of the repair.

R (3) Remove in-situ blade blending equipment.

R (a) On completion of in-situ blade blending repair,
R remove blending tool from the engine.

R (b) Ensure that the power supply is switched OFF,
R then disconnect power unit.

R (c) Dismantle in-situ blade blending equipment and
R stow in the appropriate storage containers.

R (d) Remove the LP compressor turning equipment
R (Ref. 72-09-01, Engine Turning).

R (4) Blending repair limits (Ref. Figs.807, 808, 809, 810, 811, 812 and 813)

(a) Blend torn, rough or scored edges to depth 20 per cent greater than the depth of damage measured using the comparator (Ref. Fig.804) provided that specified limits are not exceeded.

(b) If blends interfere, metal must be removed to produce a coupled blend.

(c) Blends must be smoothly profiled into the aerofoil shape. Leading and trailing edges should be blended into a radius and should not leave a knife-edge.

(d) Polish all blends and defective areas to achieve a good surface finish with no machining marks.

(e) Remove only the minimum amount of material consistent with specified requirements and dimensions.

(f) In Zone X, the maximum blend depth is limited to 0.010 in (0.25 mm) maximum.

(g) For opposing blends the chordal width must not be reduced by more than A, B or C, as applicable.

(h) The blending and polishing of marks is acceptable only in a radial direction, from root to tip. Some residual post blending MINOR marking around the blend is acceptable.

7. Assessment of Amount of Blending per Blade (All Stages)

A. Blades may be blended in several positions provided that the total extent of blending is not more than the equivalent of two blends in the maximum Zone Z.

B. The depth of blending is controlled by the zonal location of the damage.

C. The maximum permissible number of blended blades per stage, when blended to maximum limits is identified as L on the illustrations.

D. Where blades are not blended to the permissible maximum, this number (Ref. Para C.) may be increased, provided that the aggregate of the blending does not exceed L.

E. Permissible blending is controlled by depths e.g. Stage 1 blade.

(1) 0.600 in (15,24 mm) depth x two blends = 1.200 in (30,48 mm) total = maximum blended blade.

(2) This maximum may be obtained as defined in (a), (b) or (c), or by any combination of depths the total of which does not exceed 1.200 in (30,48 mm).

(a) 0.300 in (7,62 mm) depth x four blends.

(b) 0.150 in (3,81 mm) depth x eight blends.

(c) 0.100 in (2,54 mm) depth x twelve blends.

F. One coupled blend = two blends.

G. Dimension D blend = one blend.

H. Dimension E blend = half blend (depth assessed as RADIUS divided by 2).

8. Assessment of Blending Equivalent to L Number of Blended Blades Per Stage

A. Example for Stage 1 blade.

(1) L = three blades x 1.200 in (30,48 mm) depth = 3.600 in (91.44 mm) aggregate depth.

(2) This aggregate may be obtained as defined in (a), (b) or (c), or by any aggregate of blended blades which does not exceed 3.600 in (91,44 mm).

(a) 0.900 in (22,86 mm) depth x four blades.

(b) 0.600 in (15,24 mm) depth x six blades.

(c) 0.300 in (7,62 mm) depth x twelve blades.

R 9. Install Blanking Plugs and Engine-Dressing Items

R A. Assemble all blanking plugs removed to gain access to the LP compressor rotor blades (Ref. 72-31-00, Inspection/ Check).

R B. Assemble and secure all engine-dressing items removed or loosened to gain access to the LP compressor casing blanking plugs.

R 10. Conclusion

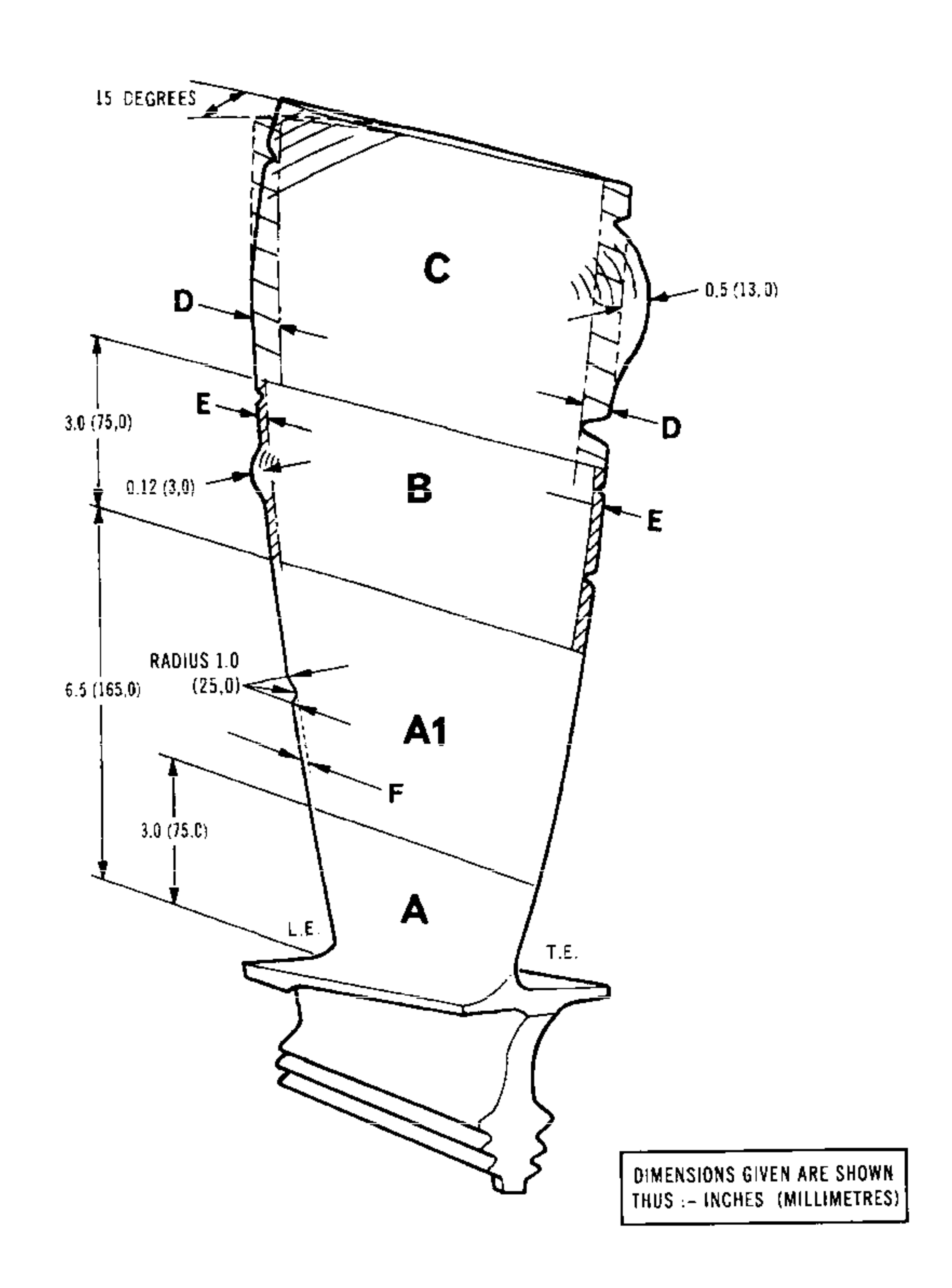
A. On completion of work close the engine bay doors (Ref. 71-00-00, Servicing).

R B. Ensure repair details are recorded.

C. A post repair inspection should be carried out after 10 flight hours and then again at the next S inspection at 230 hours (Ref. 72-09-03, Inspection/Check).

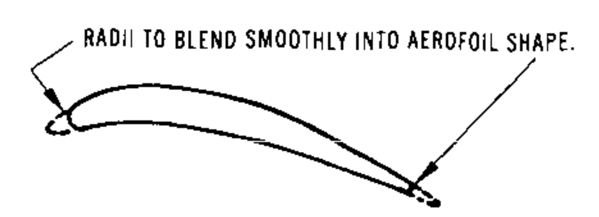
D. Rolls Royce Limited/SNECMA reserve the right to amend all or part of the acceptance standards stated in this repair procedure, as engine operational experience, with damaged blades, is gained.

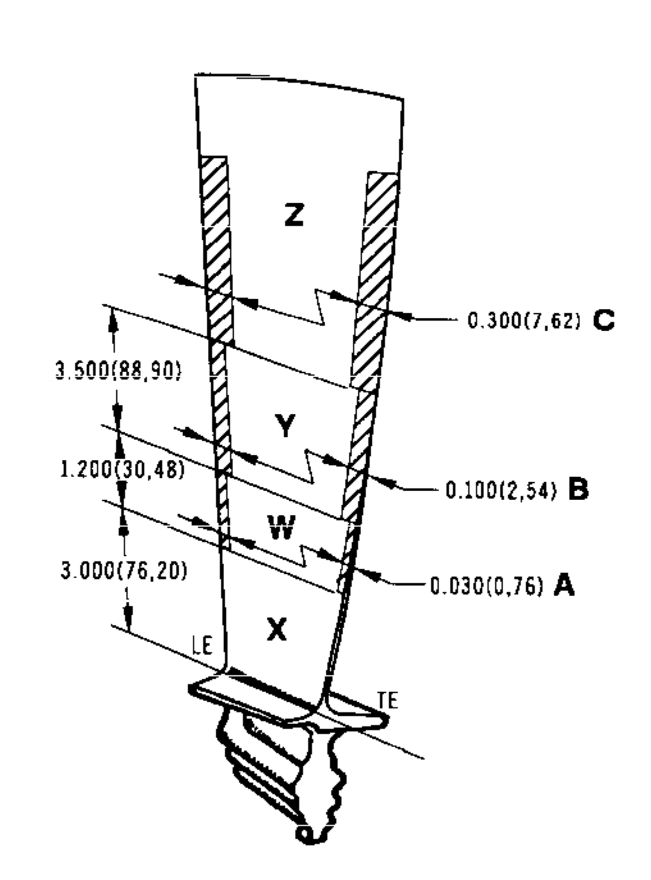
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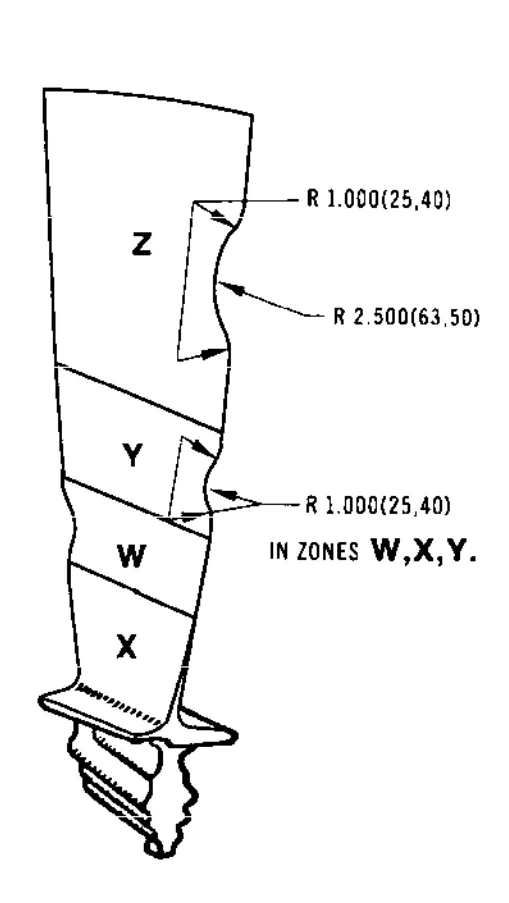


Stage 1 LP Rotor Blade - In-Situ Blending Standard
Figure 807

BS0015354/1





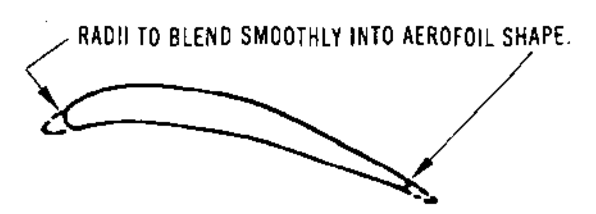


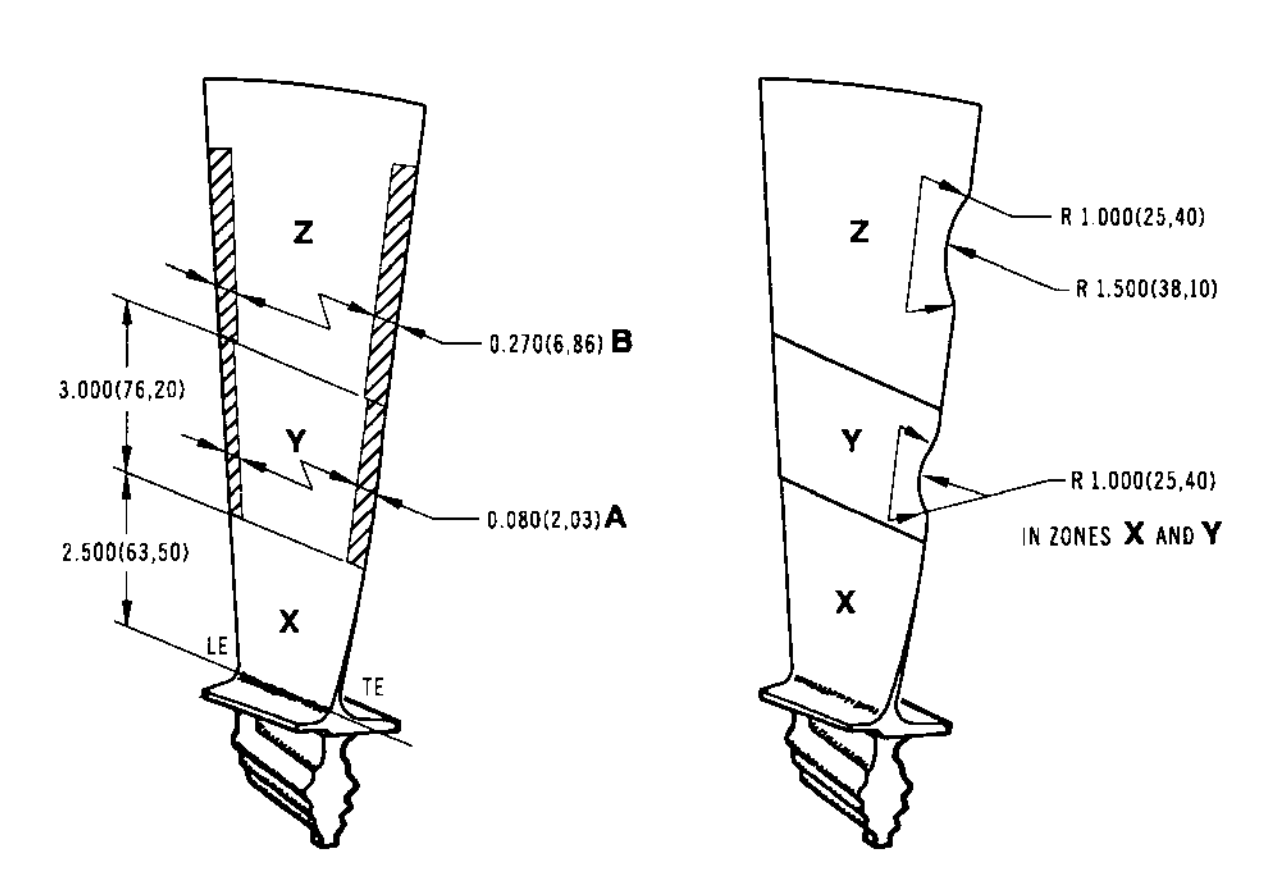
IN ZONE **X**, EDGE BLENDS 0.010 (0,25) DEEP MAX., PERMITTED.

L - MAXIMUM NUMBER OF BLADES BLENDED TO MAXIMUM = 4.

DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)

Stage 2 LP Rotor Blade - In-Situ Blending Standard
Figure 808





IN ZONE **X**, EDGE BLENDS 0.010 (0,25) DEEP MAX., PERMITTED.

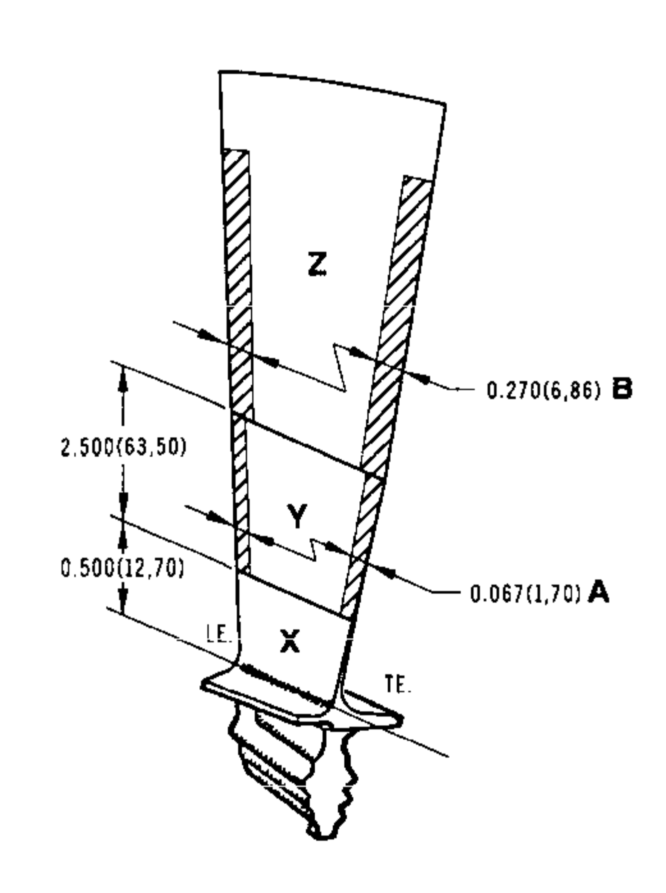
L - MAXIMUM NUMBER OF BLADES BLENDED TO MAXIMUM = 4.

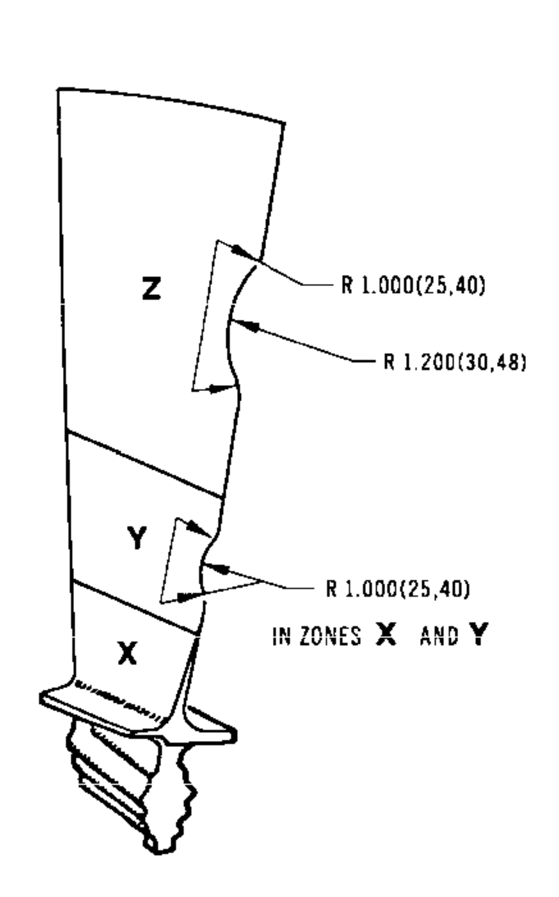
DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)

Stage 3 LP Rotor Blade - In-Situ Blending Standard
Figure 809

BS0001535 7/1

RADII TO BLEND SMOOTHLY INTO AEROFOIL SHAPE.





IN ZONE **X**, EDGE BLENDS 0.010 (0,25) DEEP MAX., PERMITTED.

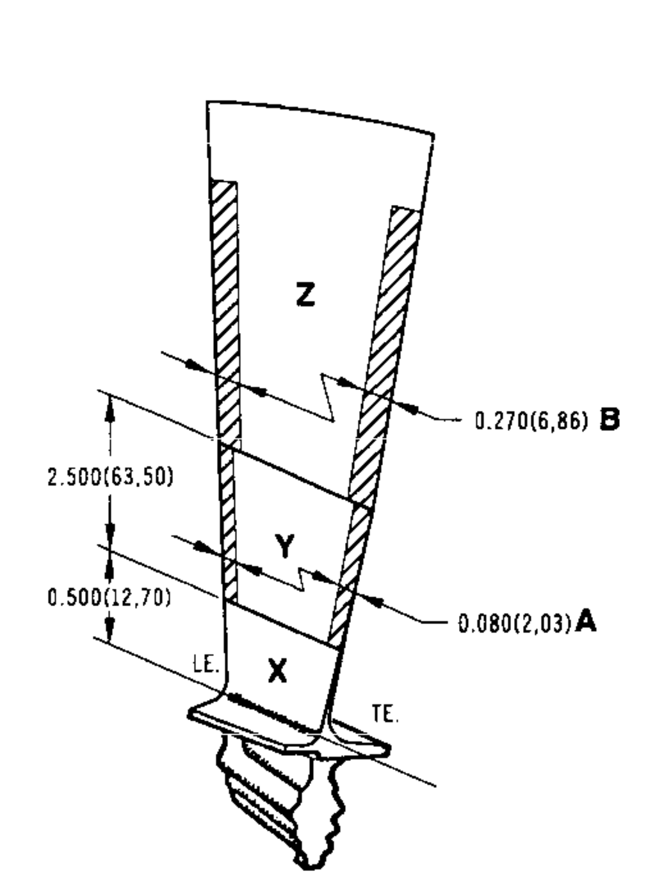
L - MAXIMUM NUMBER OF BLADES BLENDED TO MAXIMUM = 4.

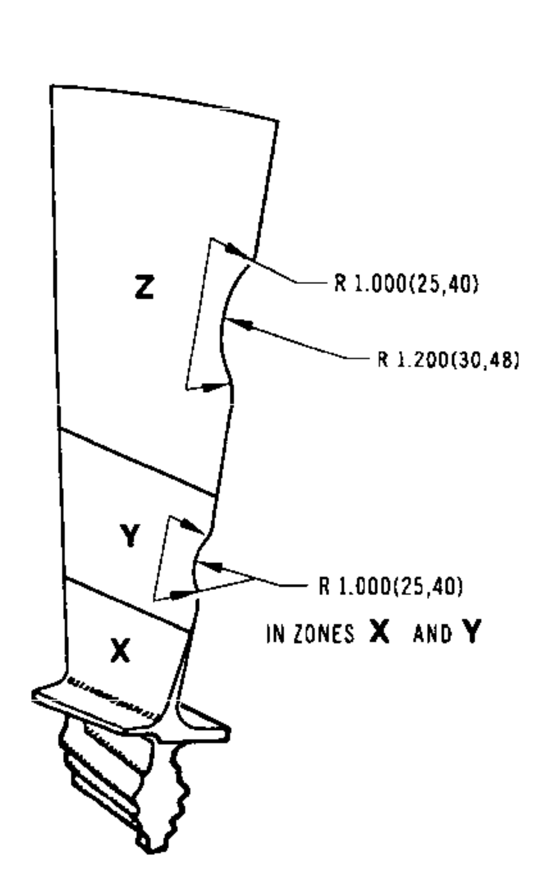
DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)

Stage 4 LP Rotor Blade - In-Situ Blending Standard
Figure 810

BS00015358/1

RADII TO BLEND SMOOTHLY INTO AEROFOIL SHAPE.





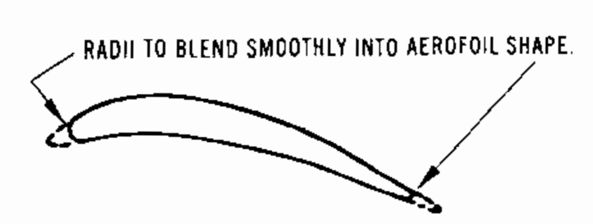
IN ZONE **X**, EDGE BLENDS 0.010 (0,25) DEEP MAX., PERMITTED.

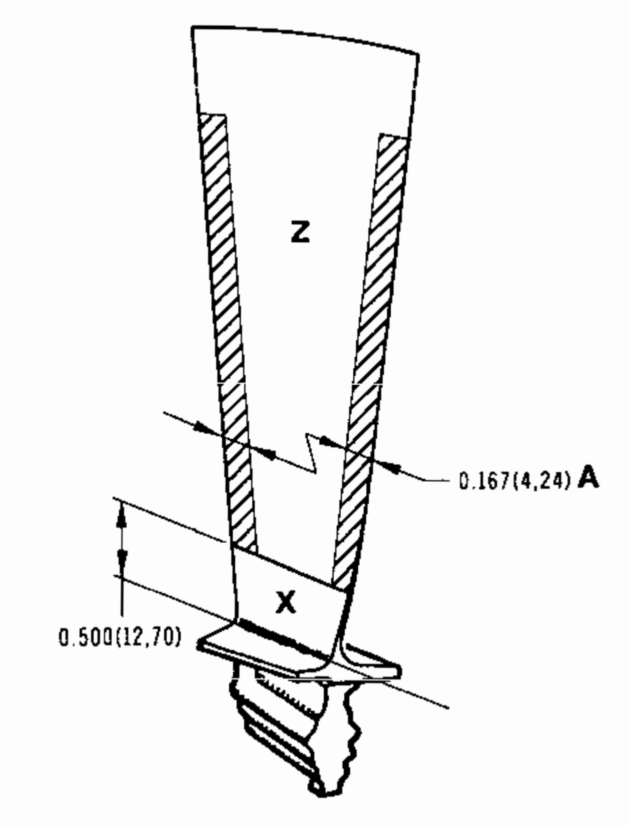
L - MAXIMUM NUMBER OF BLADES BLENDED TO MAXIMUM = 4.

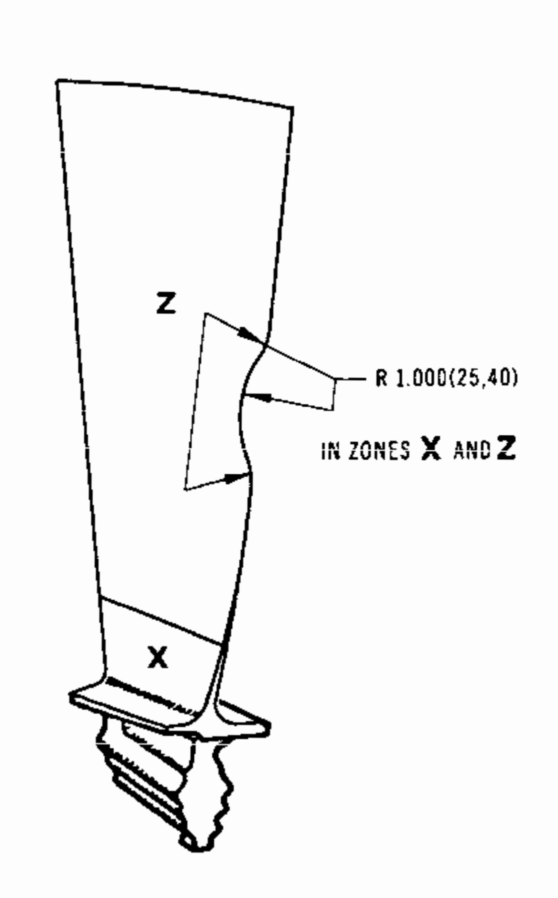
DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)

Stage 5 LP Rotor Blade - In-Situ Blending Standard
Figure 811

BS00015359/1







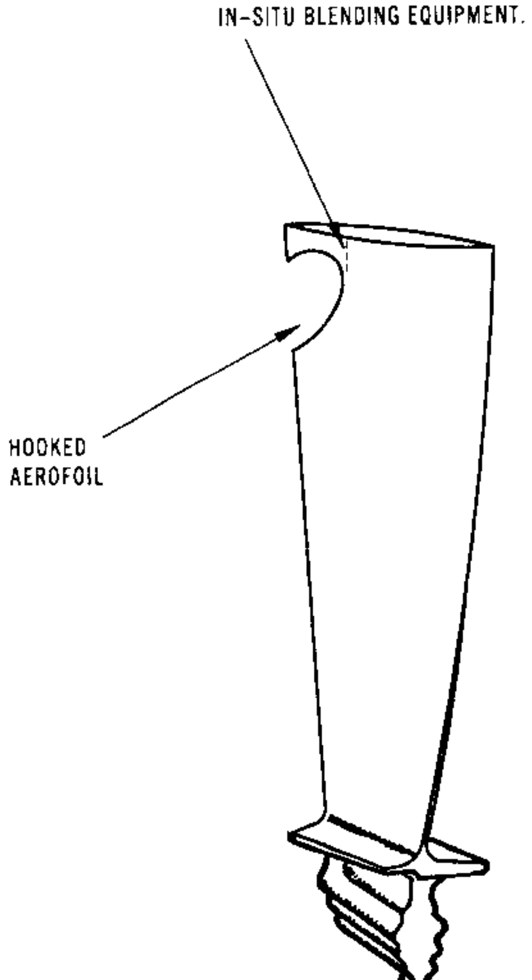
IN ZONE **X**, EDGE BLENDS 0.010 (0,25) DEEP MAX., PERMITTED.

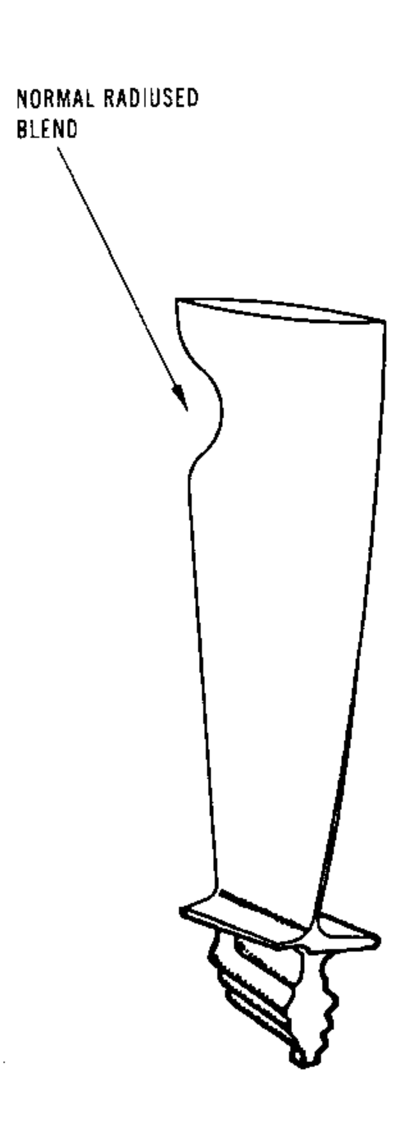
L - MAXIMUM NUMBER OF BLADES BLENDED TO MAXIMUM = 4.

DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)

Stage 6 and 7 LP Rotor Blade - In-Situ Blending Standard
Figure 812

BS00015364/1





NOT ACCEPTABLE

ACCEPTABLE

Hooked Blades
Figure 813

END OF THIS SECTION

NEXT

COMPRESSOR INTERMEDIATE CASE ASSEMBLY
DESCRIPTION AND OPERATION

1. General

The compressor intermediate case assembly is located between the LP compressor exit guide case and the HP compressor case.

2. Description

The compressor intermediate case assembly consists of an outer case and inner case connected by six aerofoil shaped hollow vanes as shown in the illustration (Ref. Fig. 001). The vanes are numbered in a clockwise direction viewed from the rear with No.1 vane at the top.

A double row LP compressor thrust bearing and a single row HP compressor thrust bearing are located in housings in the front and rear faces of the inner case. The bearing housings also provide for the attachment of air baffles to control the passage of engine internal cooling and pressurizing air.

The inner case houses the right-hand and left-hand gearbox drive shaft pinions and the bevel gear for the pulse probe drive, each drive shaft is accommodated in the case vanes, No. 3 and No. 5 vanes for the right-hand and left-hand gearboxes respectively, and No. 4 vane for the pulse probe drive.

Oil feed to the thrust bearings is conveyed through tubes in No. 2 vane, scavenge oil is returned through No. 4 vane which houses tubes to allow oil to drain to the pulse probe housing, No. 6 vane incorporates an intermediate case vent tube. The left-hand and right-hand gearboxes are mounted on the outer case which also carries the housing for the pulse probe drive bolted to the base.

CR 31081/00A

INTERMEDIATE CASE VENT
BEARING OIL FEED
1
2
3
4
5
6
LEFT HAND GEARBOX
PULSE PROBE DRIVE AND OIL SCAVENGE
RIGHT HAND GEARBOX
VIEW LOOKING FORWARD

OUTER CASE
VANE
INNER CASE
CMR 72 32 00 0 AAMO
LP COMPRESSOR THRUST BEARING
HP COMPRESSOR THRUST BEARING
REAR AIR BAFFLES
FRONT AIR BAFFLES

Intermediate Case Assembly
Figure 001

HIGH PRESSURE COMPRESSOR ASSEMBLY
DESCRIPTION AND OPERATION

1. General

The seven stage high pressure (HP) compressor assembly, shown in the illustration (Ref. Fig. 001), extends from the rear flange of the compressor intermediate case to the front flange of the HP compressor diffuser case. The HP compressor assembly comprises a rotor assembly, with a drive shaft extending rearward to the HP turbine assembly, and a case assembly incorporating stator vanes. A compressor stage is formed by a bladed rotor disk and the ring of stator vanes immediately behind the disk. The stages are numbered from front to rear.

The operation of the HP compressor assembly is similar to that of the LP compressor assemnly as described in 72-31-00.

2. Rotor Assembly

The compressor rotor is a bolted assembly supported by two bearings. Bladed disks and spacer rings are assembled between a rotor shaft front and a drive shaft, as shown.

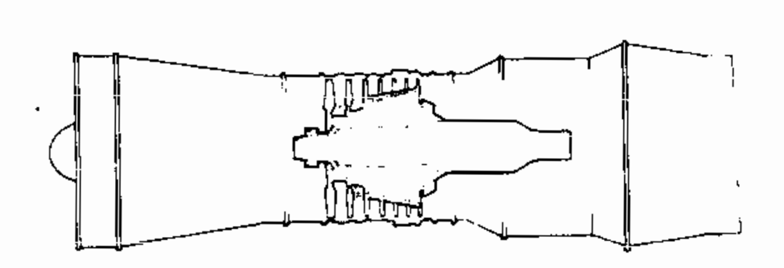
The rotor disks have fir-tree form slots equally disposed around their periphery in which the matching roots of the rotor blades engage. The blades in the first and second stages are retained by locking keys and tangs whereas the blades in the remaining stages are retained by tangs and the abutment of the spacer rings to the disk faces. When the engine is static the rotor blades possess some free movement within the fir-tree form slots in the disks, this movement is taken up when the engine is running.

The spacer rings are located between, and bolted to, the bladed rotor disks from the second to seventh stages and are numbered in relation to the stages they separate i.e., second to third stage spacer. The rotor shaft front acts as a spacer between stages one and two and is supported by the thrust bearing housed in the intermediate case.

The drive shaft, at the rear of the assembly, couples the compressor rotor disk assembly to the HP turbine rotor. The rear of the drive shaft is in splined engagement with the HP turbine driving hub and is supported by the HP turbine bearing immediately in the front of the driving hub.

There are five air sealing labyrinths situated in the HP compressor assembly as shown, the rear labyrinth is bolted to the front end of the drive shaft. To facilitate a flow of

CR 30433/00A



COMPRESSOR CASE
STATOR VANE
ROTOR BLADE
SPACER
REAR CASE
LABYRINTH
CMR 72 33 00 0 AAM0
THRUST BEARING
ROTOR SHAFT FRONT
LABYRINTHS
INNER FIXING RING
ROTOR DISK
H.P. COMPRESSOR DRIVE SHAFT

HP Compressor Assembly
Figure 001

cooling air along the outer face of the low pressure (LP) compressor shaft, an air transfer tube passes through the centre of the HP rotor assembly and connects the drive shaft and the rotor shaft front.

3. <u>Case and Vanes</u>

The case and vanes enclose the rotor assembly. An outer case, formed by a front section and rear section bolted together, contains the seven stator vane stages. The first five stages are contained in the front section and the sixth and seventh stages in the rear section. The stator vanes are housed in grooves, positioned alternately with the disks of the rotor assembly, in the outer case. Each groove has two diametrically opposed loading slots, stator vanes fitted to these positions are secured to the case. On engines to SB OL593-72-8806-313 standard, liners are installed in the grooves of the stage 6 and 7 vanes. The inner platforms of the first and second stage stator vanes are located in inner fixing rings, which provide a seal face for the labyrinths located on the rotor shaft front and the second to third stage spacer ring. On engines to SB OL593-72-8694-297 standard, anti-fret liners are installed in these fixing rings. Ducting at the top and bottom of the outer case conveys fifth stage air into the HP compressor diffuser case.

To facilitate engine internal examination of the rotor blades and stator vanes inspection ports are located in the compressor outer case, at each of the seven stages. The ports are sealed with blanking plugs.

HIGH PRESSURE COMPRESSOR ASSEMBLY - INSPECTION/CHECK

1. General

The HP compressor rotor blades can be examined without dismantling the engine by the use of optical inspection instruments inserted through ports at each stator stage. The stages 1 to 6 stator vanes and the exit guide vanes (stage 7 vanes) are not all clearly visible through the inspection ports and damage may be difficult to measure. However, damage acceptance standards are included for the stator vanes should they be required.

There are three standards of compressor casings in use, with various combinations of inspection ports at stages 4 to 7. However, accessibility is not affected by the standard of casing used. See Fig.601 and 602 for positions of the ports. The single inspection ports are sealed with blanking plugs, retaining plates and bolts and the paired ports with blanking plugs and washers. Twin ports are sealed with spherically seated blanking plugs, of which the hexagon headed plugs have locknuts. The most convenient of each pair of ports is used.

Datum blades on engines of SB OL593-72-25 standard can be identified by slots cut in the third and seventh HP compressor rotor disk. On engines of pre SB OL593-72-25 standard, paint marking may be found to have been used in some instances for datum blade identification.

Access to inspect an installed engine internally is determined by the aircraft nacelle positions and ports on left-hand or right-hand side are selected as accessible.

Certain types of blade damage can be repaired in-situ, without dismantling the engine. For details of in-situ blade blending and acceptance limits refer to 72-33-00 - Approved Repairs.

Access to inspect an installed engine internally is determined by the aircraft nacelle positions and ports on left-hand or right-hand side are selected as accessible.

A. Read the following information regarding the use of borescope equipment. This outlines how these may affect safety and their classification relative to our Procedures. The precautions listed <u>must</u> be complied with.

(1) Background and Description

Borescope inspections of internal engine components are frequently carried out. These inspections, when conducted with equipment utilising a light source box,

now require additional precautions to be taken to eliminate risk of hazard when used in an environment potentially containing combustible gasses.

Engines installed or near an aircraft, inside or outside a hangar, fall within the compass of this environment. Uninstalled engines in workshops may also be in a hazardous environment.

These environments are termed "Zone 2" areas but dedicated Zone 2 certification for equipment is not granted by the Regulatory Authority and it is deemed "UNCERTIFIED EQUIPMENT'.

A borescope kit comprises of several pieces of equipment but it is only the high intensity light source box which is of concern. Existing boxes (Uncertified Equipment) display a warning notice stating it must not be used in the presence of combustible gases.

Conditions of use of such equipment in a Zone 2 area in strict accordance with procedures (i.e. using gas monitors, etc.) would impose a condiserable maintenance/operational burden.

An acceptable relaxation of this situation has been agreed following consultations/boroscope demonstration with the Fire Protection Department; although relaxed, adequate safety standards and legal aspects are maintained provided the following precautions are adhered to.

2. Engines, Installed or near an aircraft

(a) Check aircraft fuel log to ensure it has not uplifted a wide cut fuel (Jet B) during the previous 20 hours of operation.

(b) Aircraft must not be transferring fuel.

(c) Working inside aircraft fuel tanks must not be in progress.

(d) Flammable Liquids with a flash point below 90°F (32°C) must not be used within the Remotely High Risk area - as defined in Section 5.2, EDP-P-FIRE 4.

(e) Spraying or use of Petroleum Based Adhesives must not be permitted.

R B (f) Liquid Petroleum Gases must not be used within
R B the Remotely High Risk area.

R B (g) If highly flammable liquids are present and
R B "Uncertified Equipment" needs to be used or if
R B any of the above conditions cannot be met, then
R B Section 5.3 of EDP-P-FIRE 4 must be vigilantly
R B followed.

R B (h) Where applicable, Bonding must take place.

R B (3) <u>Engines in Workshops</u>

R B (a) Conditions (2)(d), (2)(e), (2)(f) and (2)(g)
R B apply.

2. <u>Tools and Equipment</u>

Probe	Part of kit PE.35891	PE.15864
Sleeve (retained on probe)...	Part of kit PE.35891	PE.28892
Probe	Part of kit PE.35891	PE.15865
Sleeve (retained on probe)...	Part of kit PE.35891	PE.28888
Light transmitting cable ...	Part of kit PE.35891	PE.24099
Right angle eyepiece... ...	Part of kit PE.35891	S3S.10360000
Probe eyepiece...		PE.15969
Light source box		PE.24304

3. <u>Terminology for Damage</u>

A. Apply the following definitions to the terms used to describe damage to LP compressor rotor blades and stator vanes:

(1) <u>Crack.</u> Visible partial separation of material which may progress to a complete break (a break is defined as a separation by force into two or more pieces).

(2) <u>Curl.</u> Tips of blades or vanes curled over due to rubbing.

(3) Dent. An indentation usually caused by impact of an object; parent metal is displaced, seldom separated.

(4) Nick. A sharp surface indentation.

(5) Score. Deep scratch.

(6) Scratch. Light, narrow, shallow mark; material is not removed.

(7) Tear. Separation by pulling apart.

4. Examination of HP Compressor Rotor Blades and Stator Vanes

NOTE: Table 601 below details which stages of the H.P. Compressor can be viewed through the inspection ports located around the compressor casing. The Table also establishes whether the trailing edge or leading edge is being viewed.

Inspection Port No.	Number of Port(s) Location	Location of Ports	View Looking Forward	View Looking Rearward
HP 1	2	About 3 & 9 o/c position	T/E-HP1	L/E-HP2
2	2	"	" -HP2	" -HP3
3	2	"	" -HP3	" -HP4
4	2	"	" =HP4	" =HP5
5	2	"	" -HP5	" -HP6
6	2	"	" -HP6	" -HP7

R B

Inspection Port No.	Number of Port(s) Location	Location of Ports	View Looking Forward	View Looking Rearward
7	2	At 9 o/c posn. (View from rear)	T/E-HP7	-

Table 601 (concluded)

A. Prepare Engine for Examination (Ref. Fig.601 and 602).

(1) Open engine bay front doors (Ref.71-00-00, Servicing).

(2) Install HP rotating assembly hand turning equipment (Ref. 72-09-01).

(3) Remove an accessible blanking plug from position at stage to be inspected as follows:

(a) Stages 1 and 2. Unscrew and withdraw blanking plug. Do not remove retaining bolts or retaining plate.

(b) Stages 3 and 4. Slacken locknut, unscrew and withdraw blanking plug complete with locknut.

<u>NOTE 1:</u> Alternative stage 4 blanking plugs are the same as stages 1 and 2 plugs.

<u>NOTE 2:</u> It may be necessary to remove the probe mounting block for better access, it should be noted that this may result in the shearing of the bolts in the compressor casing. If this occurs, refer to the Rolls-Royce, Olympus 593 Project Office, Filton, Bristol, for corrective action.

(c) Stages 5 and 6. Unscrew and remove blanking plug and washer.

(d) Stage 7. Unscrew and withdraw blanking plug.

<u>NOTE 1:</u> Alternative stage 7 blanking plugs are the same as stages 1 and 2 plugs.

R NOTE 2: It may be necessary to remove the probe mounting block for better access, it should be noted that this may result in the shearing of the bolts in the compressor casing. If this occurs, refer to the Rolls-Royce, Olympus 593 Project Office, Filton, Bristol, for corrective action.

(4) Prepare and test the optical inspection equipment (Ref.72-09-03). Select probes, to be used in conjunction with light source box PE.24304 and cable PE.24099, at the specific locations as follows:

CAUTION: DO NOT MOVE LIGHT SOURCE BOX WHILE, SWITCHED ON OR WITHIN 30 SECONDS OF SWITCHING OFF. BULB FILAMENT IS NOT SHOCK RESISTANT WHEN HOT.

(a) Stages 1 to 4, probe 8 mm dia x 19 in. long, PE.15864.

(b) Stages 5 to 7, probe 5.5 mm dia x 19 in. long, PE.15865. Examine stage 7 on engines installed in bays No.1 or No.3 with right angle eye-piece attached to probe.

B. Examine the Rotor Blades and Stator Vanes.

(1) Examine each stage of the compressor blades and as far as possible, the stator vanes through the locations as follows:

(a) Insert probe and ensure free penetration.

NOTE: The protective sleeve must be retained on the probe at all times except when removal is essential for insertion of the probe or its effective use when inserted.

(b) Switch on probe illumination and commence examination. For quantities of blades per stage, refer to Table 606.

(c) Carefully examine the blades for damage by changing the probe position or varying the depth of insertion. Turn the engine as necessary to ensure full coverage of all surfaces to be examined.

(d) Record extent of any damage found, using the terms given in paragraph 3 and by reference to the illustrations (Ref.Fig.603 and 604) (Ref.Fig.605 and 606). If a photographic record of the damage is required, use the equipment and procedures detailed in 72-09-04.

(e) Assess the acceptability of any damage by comparison of the examination results with the acceptance standards stated in paragraph 5.

(2) On completion of the compressor examination, switch off illumination and withdraw probe.

(3) Remove hand turning equipment (Ref.72-09-01).

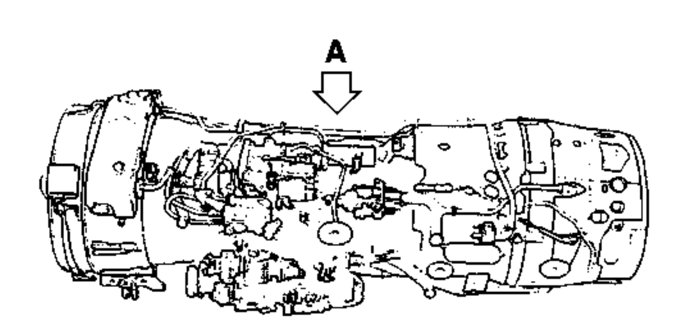
C. Install Blanking Plugs Removed for Engine Internal Examination.

(1) Procedure for ports at stages 1 and 2.

(a) Apply lubricant A (Ref.70-00-01, Servicing and Storage Materials) and screw plug into its location.

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RETAINING PLATE

BLANKING PLUG

STAGES 1 AND 2

STAGE 4 (ALTERNATIVE)

STAGE 1
STAGE 2
STAGE 3
STAGE 4
STAGE 5
STAGE 6

INSPECTION PORT LOCATIONS AT A

LOCKNUT

BLANKING PLUG

STAGE 3

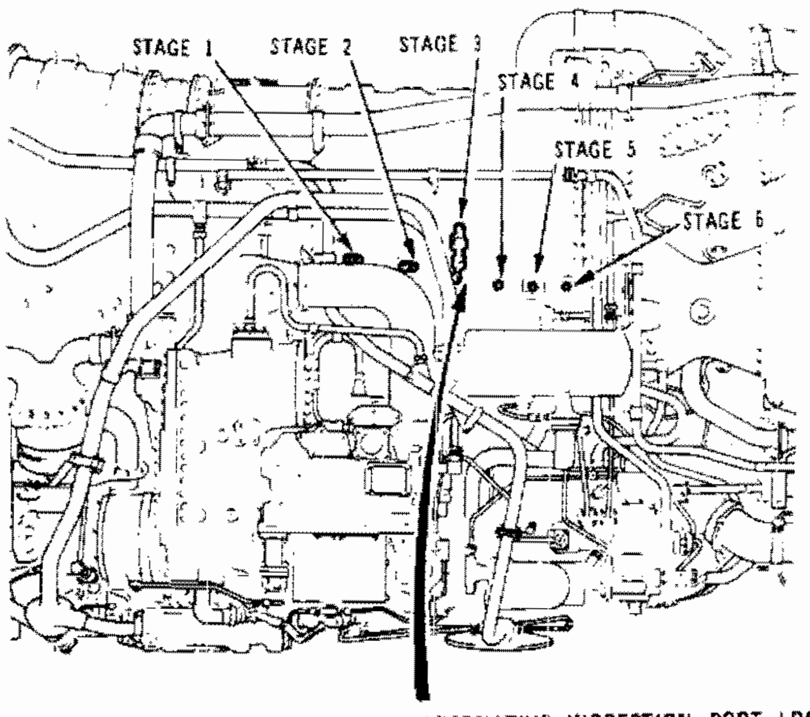
WASHER

BLANKING PLUG

STAGES 5 AND 6

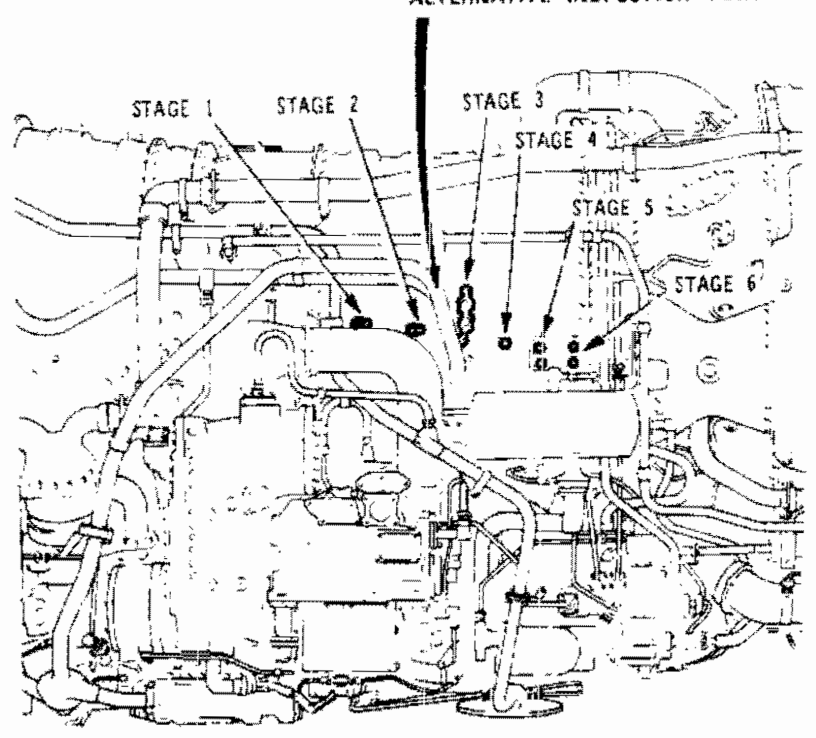
Left-Hand Side Inspection Port Locations
(Sheet 1 of 2)
Figure 601

CR 3353I/0DA



ALTERNATIVE INSPECTION PORT LOCATIONS AT

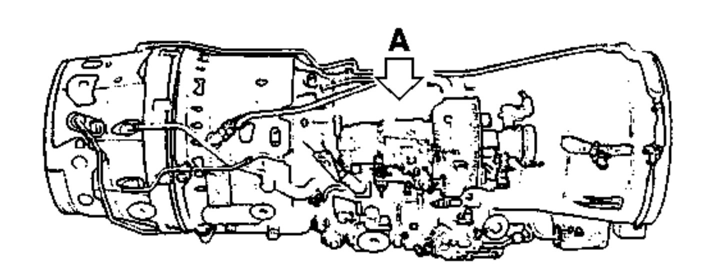




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Left-Hand Side Inspection Port Locations
(Sheet 2 of 2)
Figure 601

CR 31135/00C
BS00030383/2





FORWARD

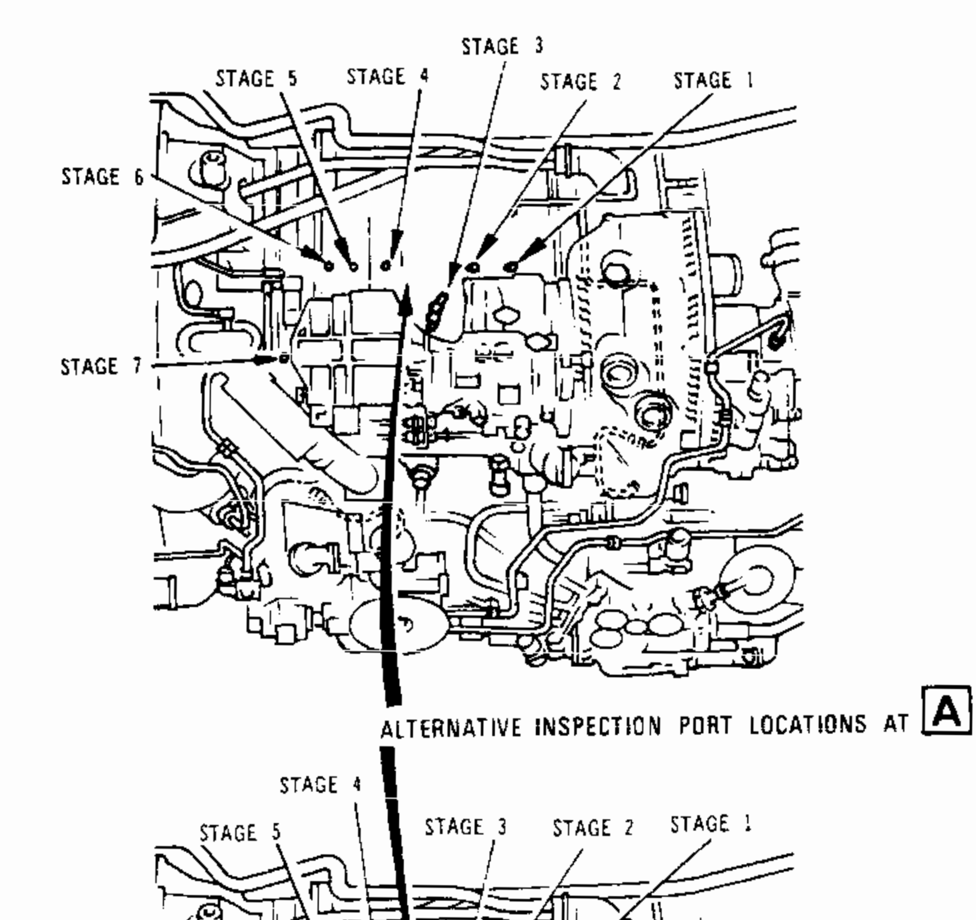
STAGE 5 STAGE 4 STAGE 3 STAGE 2 STAGE 1
STAGE 6
STAGE 7
INSPECTION PORT LOCATIONS AT A

RETAINING PLATE
BLANKING PLUG
STAGES 1 AND 2
STAGE 7 (ALTERNATIVE)
STAGE 4 (ALTERNATIVE)

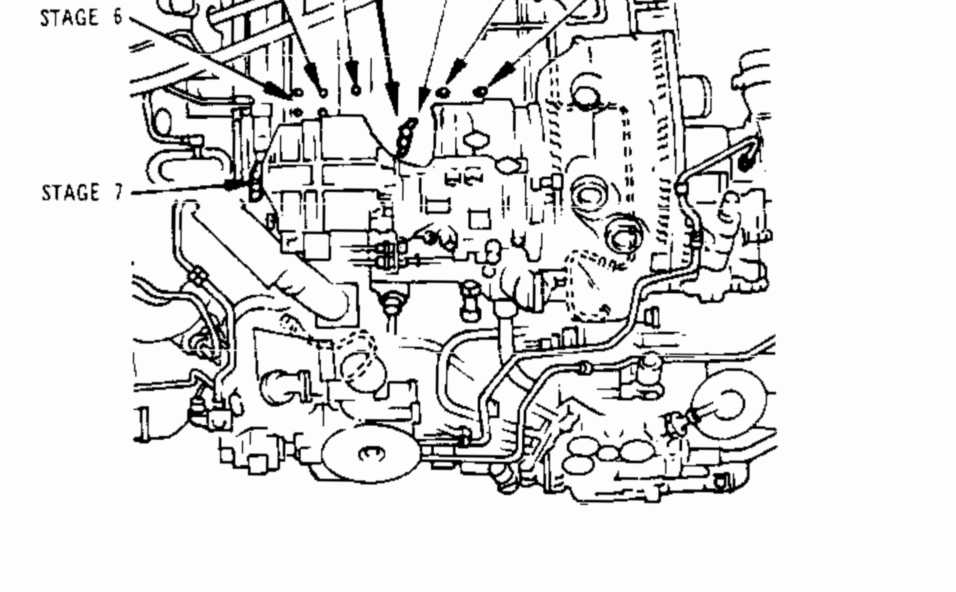
BLANKING PLUG
WASHER
STAGES 5 AND 6
BLANKING PLUG
LOCKNUT
BLANKING PLUG
STAGE 3

Right-Hand Side Inspection Port Locations
(Sheet 1 of 2)
Figure 602

CR 33532 00A



ALTERNATIVE INSPECTION PORT LOCATIONS AT A



CMR 72 33 00 6 BAMB

Right-Hand Side Inspection Port Locations
(Sheet 2 of 2)
Figure 602

(b) Torque-tighten plug to 65 lbf in (7,3 N.m). Wire-lock plug and adjacent bolts together.

(2) Procedure for ports at stage 3.

(a) Ensure that locknut is screwed back under head of blank.

(b) Apply lubricant A, screw blank into its location and torque-tighten to 70 lbf in (7,9 N.m).

(c) Hold plug with spanner to prevent turning, then screw in locknut and torque-tighten to 370 lbf in (41,8 N.m). Wire-lock locknut to adjacent locknut.

(3) Procedure for ports at stage 3 if probe mounting block has been removed.

(a) Apply lubricant 'A' to two bolts, then offer the probe mounting block to the left-hand side of the case, correctly position the block to align it with the probe vane and threaded holes, then secure the block with two sleeves and bolts. Torque-tighten the bolts to 100 lbf in (11,5 N.m), then wire-lock each bolt to the adjacent lock hole in the block.

(b) Apply lubricant 'A' to the blanking plug. Screw a locknut onto the plug until the nut is at the opposite end to the nipple. Screw the plug into the mounting block and seat the nipple in the front case. Using a square drive, torque-tighten the plug to 70 lbf in (7,9 N.m). Hold the plug stationary, and torque-tighten the locknut to 370 lbf in (41,8 N.m). Assemble another blanking plug and locknut to the remaining hole in the mounting block and torque-tighten. Wire-lock the two plugs together.

(4) Procedure for ports at stage 4 when parallel sided blanking plug with locknut is used.

(a) Install blanking plug as detailed in paragraph (2)(a), (b) and (c).

(5) Procedure for ports at stage 4 when flanged blanking
R plug is used.

R (a) Install blanking plug as detailed in paragraph
R (1)(a) and (b).

R
R

(6) Procedure for ports at stage 4 if probe mounting block has been removed.

(a) Apply lubricant 'A' to two bolts, then offer the probe mounting block to the left-hand side of the case, correctly position the block to align it with the probe and threaded holes, then secure the block with the two bolts. Torque-tighten the bolts to 100 lbf in (11,5 N.m), then wire-lock each bolt to the adjacent lock hole in the block.

(b) Apply lubricant 'A' to the blanking plug. Screw a locknut onto the plug until the nut is at the opposite end to the nipple. Screw the plug into the mounting block and seat the nipple in the front case. Using a square drive, torque-tighten the plug to 70 lbf in. (7,9 N.m). Hold the plug stationary, and torque-tighten the locknut to 370 lbf in (41,8 N.m). Assemble another blanking plug and locknut to the remaining hole in the mounting block and torque-tighten. Wire-lock the two plugs together.

(7) Procedure for ports at stages 5 and 6.

R (a) Assemble washer to blanking plug, apply
R lubricant 'A' and screw blanking plug into its
R location.

R (b) Torque-tighten plug to 65 lbf in (7,3 N.m) and
R wire-lock to adjacent plug.

(8) Procedure for ports at stage 7 when flanged blanking
R plug is used.

(a) Install blanking plug as detailed in paragraph
R (1)(a) and (b).

(9) Procedure for ports at stage 7 when circular headed blanking plug is used.

(a) Apply lubricant 'A' and screw plug into its location. Torque-tighten to 70 lbf in (7,9 N.m) and wire-lock to adjacent plug.

R R (10) Procedure for ports at stage 7 if probe mounting block has been removed.

R R R R R R R (a) Apply lubricant 'A' to four new bolts, then position the probe mounting block on the lower right-hand side of the case and secure the block by inserting the bolts through the block and screwing them into the bolted vanes. Torque-tighten the bolts to 100 lbf in. (11,5 N.m), then wire-lock the two bolts of each vane together.

R R R R R R (b) Apply lubricant 'A' to the two blank plugs then screw the two plugs into the probe mounting block using a square drive. Torque-tighten each plug in turn in gradual stages until both reach a torque of 70 lbf in. (7,9 N.m), then wire-lock the plugs together.

(1) Close engine bay doors (Ref. 71-00-00, Servicing).

5. Acceptance Standards

A. Damage to HP Compressor Rotor Blades (Ref. Fig.603 and 604)

R (1) No (unblended) HP2 Rotor Blade damage is acceptable.

R (2) Zone A. No damage is acceptable.

CAUTION: THE FOLLOWING BLADE DAMAGE IS PERMITTED PROVIDED THE CONDITIONS IN PARA.C. ARE COMPILED WITH. HEAVIER DAMAGE MAY BE ACCEPTED FOR UP TO 8 FLIGHTS PROVIDED THE DAMAGE CONFORMS TO THE REQUIREMENTS OF PARA.D.

R (3) Zone B (Stage 1, stages 3 to 5 rotor blades). Accept the following damage:

(a) Nicks, tears and surface dents within limits given in Table 602.

ACCEPTABLE DAMAGE ZONE B	HP COMPRESSOR STAGES ROTOR BLADES ONLY	
R	1	3-5
	DIMENSIONS ARE SHOWN THUS:	INCHES (MILLIMETRES)
Nicks or tears in one edge to depths (E) not exceeding:	0.06 (1,5)	0.06 (1,5)
Nicks or tears both edges to depth (E) not exceeding:	0.06 (1,5)	0.06 (1,5)
Dents on a surface which do not deform the surface behind, up to a diameter (G) of:	0.15 (4,0)	0.15 (4,0)

ACCEPTABLE DAMAGE ZONE B	HP COMPRESSOR STAGES ROTOR BLADES ONLY 1	3-5
The least amount of undeformed material which must be between surface dents:	0.5 (13,0)	0.25 (6,0)

HP Compressor Rotor Blade Damage
Table 602

(b) A dent in one edge up to a laterial displacement of 0.12 in. (3,0 mm).

(c) Light scratches/scores.

R (4) Zone C. Accept the following damage:

(a) Nicks, tears and dents within limits given in Table 603.

(b) Light scratches/scores

(c) Tip rubbing with light curling and cracks running from the tip up to 0.25 in. (6,0 mm) long.

R (5) Throughout the HP compressor no more than 100 damaged blades are acceptable.

ACCEPTABLE DAMAGE ZONE C	HP COMPRESSOR STAGES ROTOR BLADES ONLY 1	3-7
	DIMENSIONS ARE SHOWN THUS:	INCHES (MILLIMETRES)
Nicks or tears in one edge to depths (D) not exceeding:	0.12 (3,0)	0.1 (2,5)
Nicks or tears both edges to depth (D) not exceeding:	0.12 (3,0)	0.12 (3,0)

ACCEPTABLE DAMAGE ZONE C	HP COMPRESSOR STAGES ROTOR BLADES ONLY 1	3-7
A dent in one edge up to a lateral displacement of:	0.12 (3,0)	0.12 (3,0)
Dents on a surface, which do not deform the surface behind, up to a diameter (H) of:	0.15 (4,0)	0.15 (4,0)
The least amount of undeformed material which must be between surface dents:	0.5 (13,0)	0.25 (6,0)

R

HP Compressor Rotor Blade Damage
Table 603

B. Damage to HP Compressor Stator Vanes (Ref. Fig.605 and 606)

(1) Zone A. No damage is acceptable.

(2) Zone B (Stages 1 and 2 vanes only). Accept the following damage (Ref. Fig. 605):

(a) Nicks, tears and surface dents within limits given in Table 604.

ACCEPTABLE DAMAGE ZONE B	HP COMPRESSOR STAGES STATOR VANES ONLY 1-2
DIMENSIONS ARE SHOWN THUS: INCHES (MILLIMETRES)	
Nicks or tears in one edge to depths (E)	

ACCEPTABLE DAMAGE ZONE B	HP COMPRESSOR STAGES STATOR VANES ONLY 1-2
not exceeding:	0.04 (1,0)
Nicks or tears in both edges to depths (E) not exceeding:	0.02 (0,5)
Dents on a surface, which do not deform the surface behind, up to a diameter (G) of:	0.1 (2,5)
The least amount of undeformed material which must be between surface dents:	0.3 (8,0)

HP Compressor Stator Vane Damage
R Table 604

(b) A dent in one edge up to a lateral displacement of 0.12 in. (3,0 mm).

(c) Light scratches/scores.

(3) Zone C. Accept the following damage:

(a) Nicks, tears and dents within limits given in
R Table 605

ACCEPTABLE DAMAGE ZONE C	HP COMPRESSOR STAGES STATOR VANES ONLY 1-2	3-7
DIMENSIONS ARE SHOWN THUS: INCHES (MILLIMETRES)		
Nicks or tears in one edge to depths (D) not exceeding:	0.08	0.06

ACCEPTABLE DAMAGE ZONE C	HP COMPRESSOR STAGES STATOR VANES ONLY 1-2	3-7
	(2,0)	(1,5)
Nicks or tears in both edges to depths (D) not exceeding:	0.04 (1,0)	0.03 (0,8)
A dent in one edge up to a lateral displacement of:	0.12 (3,0)	0.12 (3,0)
Dents on a surface, which do not deform the surface behind, up to a diameter (H) of:	0.15 (4,0)	0.15 (4,0)
The least amount of undeformed material which must be between surface dents:	0.3 (8,0)	0.25 (6,0)

LP Compressor Stator Vanes Damage
Table 605

(b) Light scratches/scores.

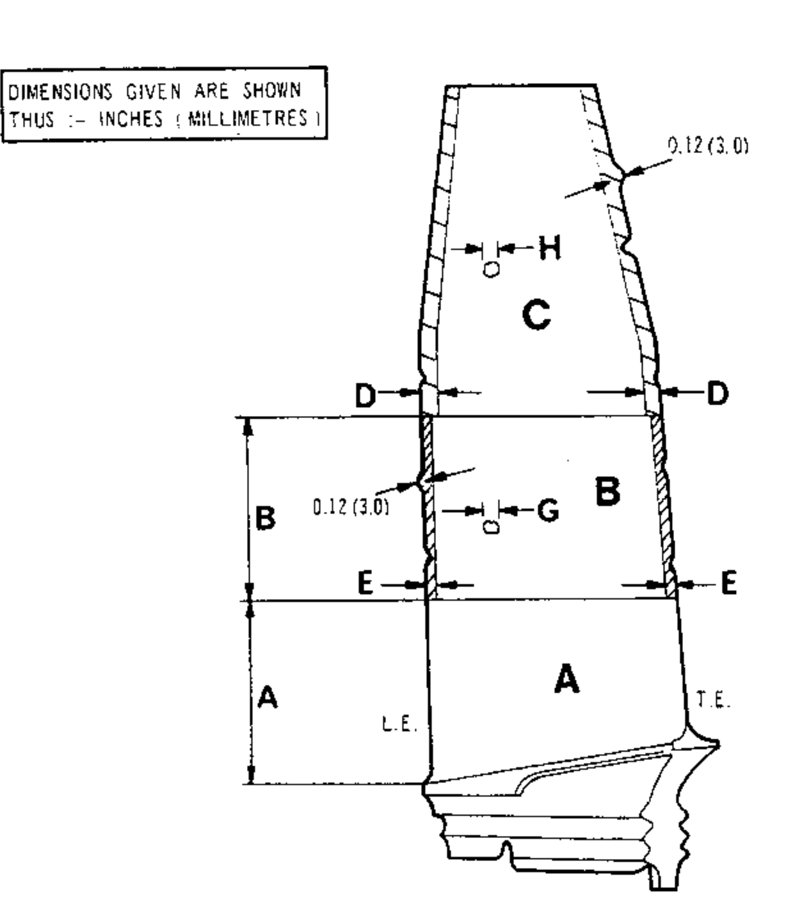
B
B
B
B
B
B

NOTE: Damage which falls outside that stated in paragraphs A and B and within paragraphs C and D must be referred to Power Unit Engineering so that monitoring Requirements may be determined and called up by E.I.

C. Conditions Applicable to the Acceptance Standards given
R in Para.A. for Stages 1 and 3 HP Rotor Blades (Ref.Fig.603).

(1) Certain blades are susceptible to periods of vibration which may exploit damage marks/blends. Therefore comply with the following conditions:

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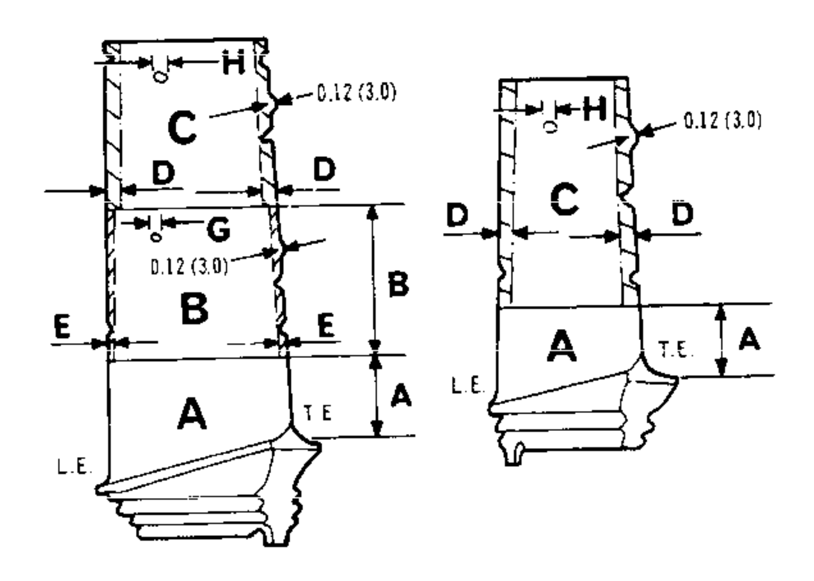


STAGE	1	2	3
DIMENSION **A**	2.0 (50.0)	1.5 (40.0)	1.5 (40.0)
DIMENSION **B**	2.0 (50.0)	1.5 (40.0)	1.0 (25.0)

R Stages 1 and 3 Compressor Rotor Blades - Acceptance Standards
Figure 603

CR 33589.00A

DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)



STAGE 4 AND 5

STAGE 6 AND 7

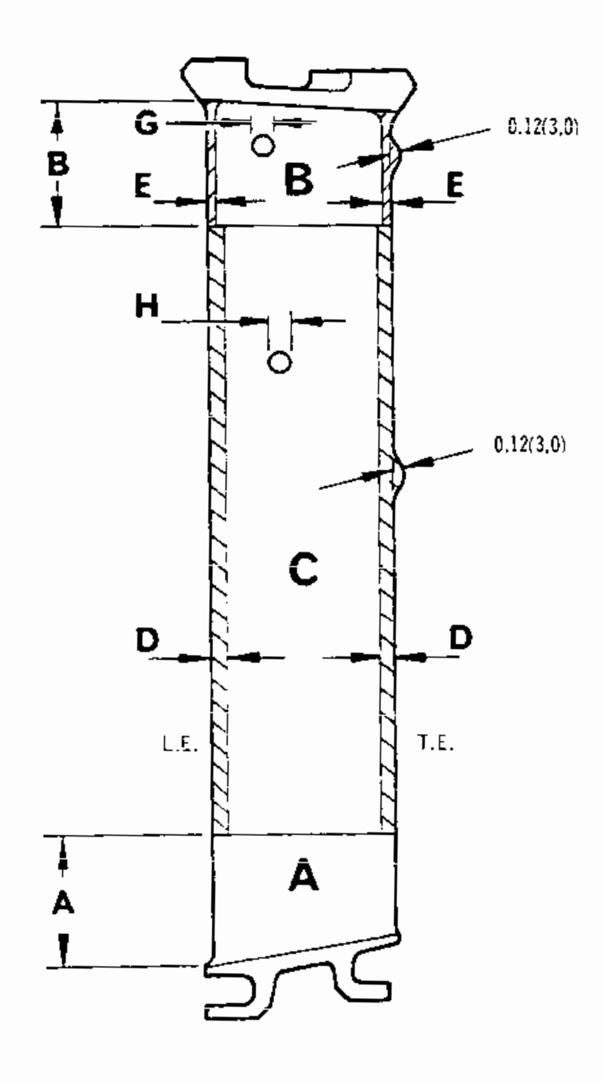
STAGE	4	5	6	7
DIMENSION A	0.75 (20.0)	0.75 (20.0)	0.75 (20.0)	0.75 (20.0)
DIMENSION B	1.0 (25.0)	1.0 (25.0)	N.A.	N.A.

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Stages 4-7 Compressor Rotor Blades -
Acceptance Standards
Figure 604

CR 33926/00A

DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)



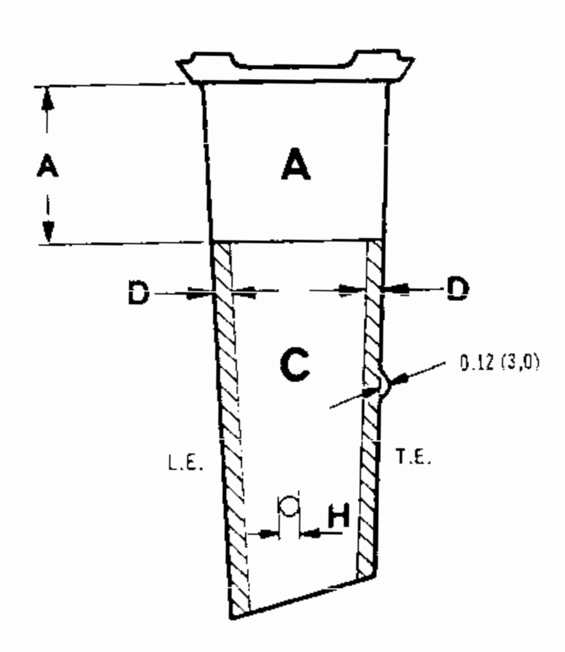
STAGE	1	2
DIMENSION **A**	1.0 (25,0)	1.0 (25,0)
DIMENSION **B**	1.0 (25,0)	1.0 (25,0)

CMR 72 33 00 6 EAM0

Stages 1 and 2 HP Compressor Stator Vanes -
Acceptance Standards
Figure 605

CR 33927/00A

DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)



STAGE	3	4	5	6	7
DIMENSION A	0.75 (20,0)	0.75 (20,0)	0.5 (13,0)	0.5 (13,0)	0.5 (13,0)

CMR 72 33 00 6 ΓAM0

Stages 3 to 6 HP Compressor Stator Vanes - and Exit Guide Vanes (Stage 7) - Acceptance Standards
Figure 606

R (a) Damage in Zone B of the Stage 1 and 3 HP rotor blades must be inspected for deterioration at intervals not exceeding 50 hours of engine flight time.

D. Damage Outside the Acceptance Standards for HP Rotor Blades and Stator Vanes (Ref.Fig.603 and 604) (Ref.Fig.605 and 606).

(1) If damage occurs in Zones B and C, (where applicable) within twice the stated acceptable limits for E, G, D and H, (where applicable), and/or the top quarter of an HP rotor blade is missing, a maximum of 8 flights may be carried out before the affected vanes/blades must be renewed.

E. Conclusion.

(1) Rolls-Royce (1971) Ltd./SNECMA reserve the right to amend all or any part of the acceptance standards, stated in paragraphs A, B, C and D, as engine operational experience, with damaged blades, is gained.

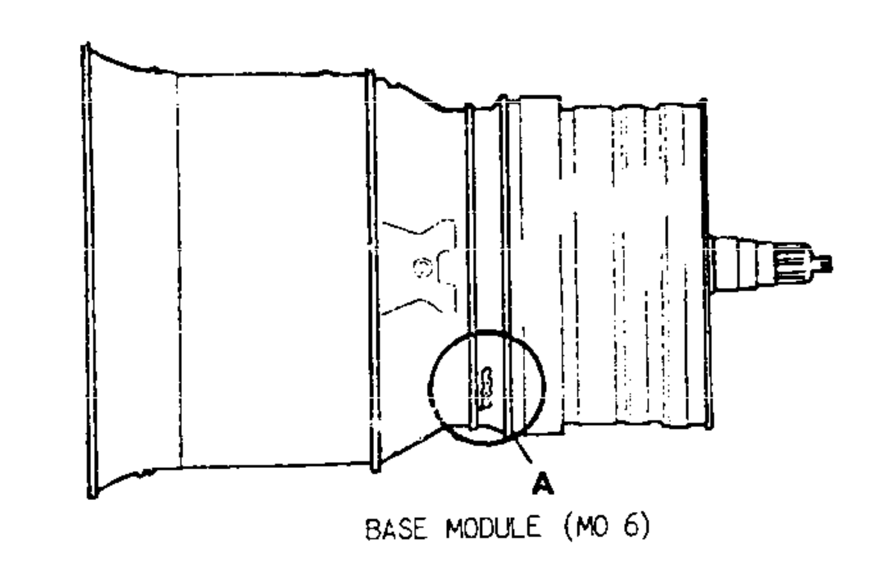
HP COMPRESSOR STAGE	QUANTITY PER STAGE
1	34
2	54
3	55
4	69
5	81
6	83
7	105

HP Compressor Blades
Table 606

6. HP Compressor Stage 7 - Rear Face Inspection

A. General.

The No.12 labyrinth static member retaining bolts are locked with Siamese locking tabs. Strip examination of an engine revealed one of these tabs missing and four others cracked. Liberation of the static member retaining bolt would cause the bolt to rattle against and damage the rear face of the No.7 HP compressor disc. The inspection detailed below looks for damage to the disc caused by liberation of a static member retaining bolt.



BASE MODULE (MO 6)

INTRASCOPE S3S 15351000

PROBE MOUNTING BLOCK (STAGE 7)

HP COMPRESSOR
STAGE 7 ROTOR DISC

STAGE 6-7
SPACER RING
SECURING
BOLTS

HP COMPRESSOR
DIFFUSER CASE

NO. 12 LABYRINTH

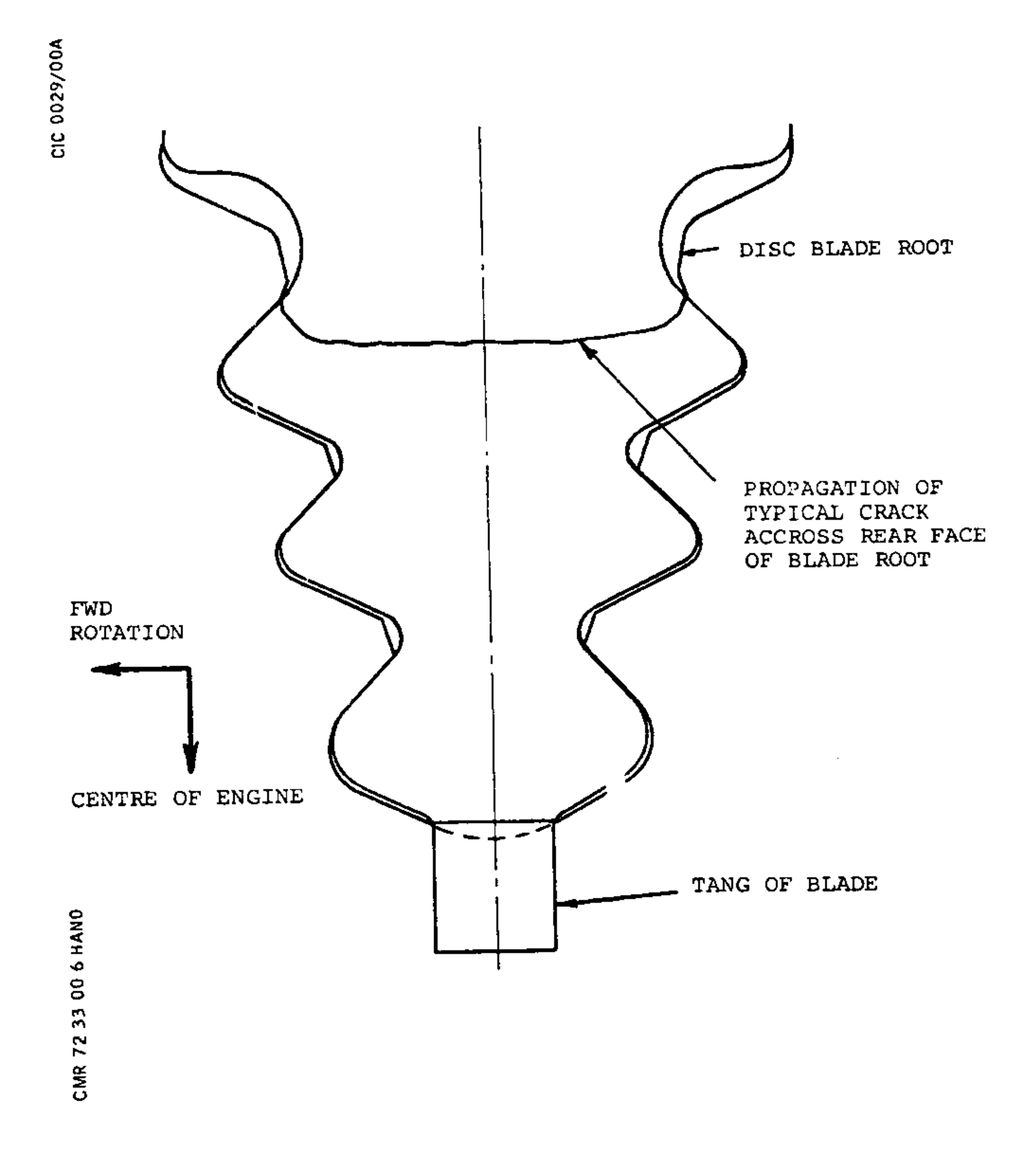
CMR 72 33 00 6 GANO

TYPICAL SECTION AT A

Inspection of Engine/Base Module
Figure 607

B

R



HP Compressor Stage One Blade Root
Figure 608

B

R

B. Tools and Equipment.

Item	Part Number	Stores Code
Borescope 5,5 mm x 13" forward view	S3S153510000	-
Fibre light guide	-	HZAC 1753 (Part of kit-HWAK 1043)
Light source box	-	GEEB 0308
Extension lead - 200'	-	GWAC 1292
Hand Turning Adaptor		HZAJ 1127
4" x 1/2" drive extension bar	-	-
1/2" drive torque wrench 0-1000 lbf-in	-	-

C. Examination (Ref.Fig.607)

(1) Remove HP Compressor Stage 7 borescope blanking plug.

(2) Insert borescope through gap between HP compressor Stage 7 disc and diffuser case extension so that as much as possible of the rear rim of the disc and of stage 6 - 7 spacer ring securing bolts can be seen.

(3) Inspect immediately - visible area for any signs of damage on rotor disc rim, spacer ring securing bolts or rotor blades.

CAUTION: Ensure that the borescope probe is clear of the rotor disc and blades during engine turning to avoid damage to blades or borescope.

(4) Using hand turning gear, continue inspection to cover complete circumference of disc. Refer to MM 72-09-01 for details on hand turning.

(5) Report any suspect damage to Power Unit Engineering immediately.

(6) Provided no damage is found, restore engine to serviceable condition.

7. HP COMPRESSOR STAGE ONE BLADE ROOT INSPECTION

A. Equipment and Materials.

Description	Code No.
Borescope - 5,5 mm x 19"	HZAE 1379
Fibre Light Guide (part of kit HWAK 1043)	-
Light Source box	GEEB 0308
Extension Lead - 200 ft.	GWAC 1292
Aeroshell Grease 8	NFLA 6007

B. Inspection Procedure.

(1) Remove one of the HP compressor stage one borescope plugs located on the compressor case at 3 and 9 o'clock position (depending on bay position.

(2) Remove the HP spool hand turning adaptor coverplate located on the forward face of the R/H gearbox.

(3) Insert borescope into the engine ensuring that the probe passes between the gap between the stage one rotor blade inner platform and stage one stator blade inner platform.

NOTE: On some engines it may be fond that the 5,5 mm borescope is too large for this application. A 4,5 mm diameter borescope should be used in this instance.

(4) Looking forward, position the borescope so that the top serration of the blade is in view (Ref.Fig.608).

NOTE: It is not possible to view the complete top serration in a static condition.

(5) Fit hand turning gear (Ref.72-09-01).

(6) Slowly rotate HP spool and inspect all 34 blades root serrations for cracks in the are shown in figure ***//HAND//***.

NOTE: Do not confuse the disc root with that of the blade root. The bottom (inner) part of the blade has a tang (Ref.Fig.608).

(7) Cracks found in the blade root will result in an unserviceable engine and should be reported to Power Unit Engineering.

(8) On completion of inspection, lubricate borescope plug with Aeroshell 8 and refit plug. Torque tighten to 30 to 40 lbf-in. and wirelock.

(9) Fit the HP spool hand turning adaptor coverplate and new gasket (P/N B479605) to the gearbox and torque-tighten to 110 - 120 lbf in. Lubricate bolts with engine oil where necessary.

8. <u>HP COMPRESSOR NO.12 LABYRINTH REAR ATTACHMENT BOLTS INSPECTION</u>

A. Inspection Procedure.

(1) Remove the HP compressor diffuser case to overboard cowling LH tube and the thermocouple from the tube (Ref.75-02-07).

(2) Remove the exhaust diffuser to duct LH tube and its elbow (Ref.75-02-05).

(3) Connect the HP turning equipment (Ref.72-09-01).

(4) Pass the guide tube tool (Part No.3BA 82042), crooked end first, up through No.6 vane of the diffuser case.

(5) Insert the intrascope through the tool until it is possible to inspect a nut/bolt shank of a rear attachment bolt; it may be necessary to carefully move the tool/intrascope to achieve this.

<u>NOTE:</u> View towards the front of the engine.

(6) Check each of the eight nut/bolt shanks in turn using the turning equipment to rotate the No.12 labyrinth. A half turn of the turning equipment equals one full turn of the labyrinth.

(7) Reject the engine if one or more nut/bolt shank is missing.

(8) Remove the intrascope, tool and turning equipment, then re-install the removed components (Ref.72-09-01, 75-02-05 and 75-02-07).

HIGH PRESSURE COMPRESSOR ASSEMBLY APPROVED REPAIRS

1. General

The instructions given in this chapter deal with the in-situ blending and polishing of damaged Stage 1-7 HP Compressor Rotor Blades.

In-situ blending and polishing of Stage 1 to 7 blades is achieved through the inspection ports on the HP Compressor Casing using the blade blending kit (Tool Item No.3146).

It is recommended that two skilled operatives be used to assess the extent of blending required before using the
R procedures contained in this chapter. It is recommended
R that the Blade Blending Training Aid is used to maintain
R operatives blending proficiency, using scrapped blades
R (Ref.Para.3.).

The debris produced by this process will not normally be harmful to the engine. However, if large pieces of blade become detached during the procedure, contact the Olympus 593 Project Office, Rolls-Royce plc, Filton, Bristol.

2. Tools and Equipment

DESCRIPTION	PART NO.
Blade Blending Kit...	S3S.20282000
Comprising:	
Blending Tool	5.08036.002
Borescope	6.04044.072
Power Unit	5.00024.95
Power Unit Supply Cable (13 A Plug) ...	72325.178
Power Unit Supply Cable (16 A Plug) ...	72325.179
Tool Set (Box 1) (Ref. Table 801) ...	5.00301.123
Tool Set (Box 2) (Ref. Table 801) ...	5.00301.223
Tool Set Measurement (Box 3) ...	5.00301.134

BS00015349/1

LPC STAGE	LENGTH (MM)	CARBIDE ROUNDED CONE FORM 1	CARBIDE BALL FORM 3	DIAMOND ROUNDED CONE FORM 10	DIAMOND BALL FORM 8	POLISHER DIAMOND BALL FORM 4
7LE	45	5.00345.001	5.00345.003	5.00345.010	5.00345.008	5.00345.004
3LE, 4TE	50	5.00350.001	5.00350.003	5.00350.010	5.00150.008	5.00350.004
1TE,2LE,2TE,3LE,5TE	55	5.00355.001	5.00355.003	5.00355.010	5.00355.008	5.00355.004
3TE	60	5.00360.001	5.00360.003	5.00360.010	5.00360.008	5.00360.004
1TE, 6LE	65	5.00365.001	5.00365.003	5.00365.010	5.00365.008	5.00365.004

HPC STAGE	LENGTH (MM)	CARBIDE ROUNDED CONE FORM 1	CARBIDE BALL FORM 3	DIAMOND ROUNDED CONE FORM 10	DIAMOND BALL FORM 8	POLISHER DIAMOND BALL FORM 4
5TE,6LE	20	5.00320.001	5.00320.003	5.00320.010	5.00120.008	5.00320.004
4LE,5TE,7TE,(LPC5LE)	25	5.00325.001	5.00325.003	5.00325.010	5.00125.008	5.00325.004
1TE,2LE,2TE,3LE,3TE, 4LE,5LE (LPC5LE)	30	5.00330.001	5.00330.003	5.00330.010	5.00330.008	5.00330.004
1TE,3TE,4TE, (LPC3LE) 4LE,4TE,5TE,6TE,7LE,7TE	35	5.00335.001	5.00335.003	5.00335.010	5.00335.008	5.00335.004
2LE	40	5.00340.001	5.00340.003	5.00340.010	5.00340.008	5.00340.004

Tool Selection
Figure 801

	DESCRIPTION	PART NO.
	Adapter and Immobiliser	S3S.20255000
R	Blade Blending Training Aid	S3S.20592000
	Equipment Reference Manuals:	
	General Operating and Troubleshooting ...	GA-T023
	Olympus Mk.593-610 Specific	BB-T023-5

R 3. <u>Blade Blending Training Aid</u>

R A. General

R (1) This equipment provides a means of maintaining
R proficiency in the techniques necessary to perform
R in-situ blade blending.

R (2) The equipment comprises a box housing a simulation of
R a 3 blade section (stages 2, 3 and 4) of the HP
R Compressor Rotor. These stages provide blade samples
R of varying section and both materials used in the
R compressor, (titanium and nimonic 90).

R (3) The rotor block is fitted with a tilt mechanism
R enabling the rotor blades to be moved relative to the
R stator vanes. This enables the user to achieve the
R optimum position for the selected blend.

R (4) Calibration blades are included in a separate
R compartment, and provide engraved damage marks
R equivalent to the maximum allowable per zone, per
R stage.

R B. Equipment Operation

R (1) Load calibration blade(s) into position and tighten
R clamp block to secure.

R (2) Close box and place in a position to best suit the
R operator.

R (3) Assess damage using blending tool fitted with
R comparitor head.

R (4) Remove calibration blade(s).

R (5) Load 'scrap' blade(s) into position, and tighten
R clamp block to secure.

R (6) Assess damage using blending tool fitted with
R comparitor head.

R (7) Record details of damage.

R (8) Replace with cutting tools and blend defect until
R removed.

R (9) Replace cutting tool with comparitor head and reassess
R size of blended defect.

R (10) Open box, remove blade and review acceptability of
R blend against criteria as detailed in repair
R procedure.

R 4. Terminology for Damage

A. Apply the following definitions to the terms used to describe damage to the HP compressor rotor blades:

(1) Bend. A sharp deviation from original line or plane (associated terms, crease, fold, kink, lean).

(2) Crack. Visible partial separation of material which may progress to a complete break (a break is defined as a separation by force into two or more pieces).

(3) Curl. Tips of blades or vanes curled over due to rubbing.

(4) Dent. An indentation usually caused by impact of an object; parent metal is displaced, seldom separated.

(5) Nick. A sharp surface indentation.

(6) Score. Deep scratch.

(7) Scratch. Light, narrow, shallow mark; material is not removed.

(8) Tear. Separation by pulling apart.

R 5. Repair Limitations

A. In-situ Blending and polishing repairs are only possible on the blade areas given in Table 801 and to the limits given in Figures 807, 808, 809 and 810.

HP Compressor Rotor Stage	Area	Repair Possible
1	Leading Edge	NO
	Trailing Edge	YES
2	Leading Edge	YES
	Trailing Edge	YES
3	Leading Edge	YES
	Trailing Edge	YES
4	Leading Edge	YES
	Trailing Edge	YES
5	Leading Edge	YES
	Trailing Edge	YES
6	Leading Edge	YES
	Trailing Edge	NO
7	Leading Edge	NO
	Trailing Edge	YES

Table 801 - HP Compressor Rotor Blade Repair Areas (Concluded)

B. Blades with dents, which deform the opposite surface of the blade, are not acceptable for blending. Reject blades with this form of damage.

C. Blends must exceed the depth of damage by 20 per cent.

D. Blends must not run out into Zone X.

E. Only blends to rectify minor damage to a maximum depth of 0.010 in (0,25 mm) are allowed in Zone X.

F. Due to limited access through the inspection ports, it is not possible to carry out blending to the tip of the blades. Damage should therefore be assessed prior to commencing any repair, to ensure that tool access is sufficient to allow full blend radii to be achieved without creating a 'hooked' aerofoil (Ref. Fig.811).

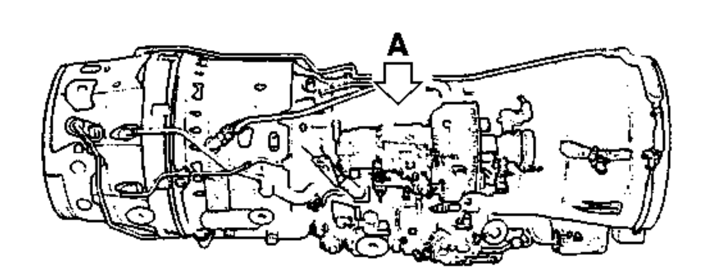
R 6. Prepare Engine for Repair

A. Open engine bay front doors (Ref. 71-00-00, Servicing).

B. Install HP compressor turning Equipment (Ref. 72-09-01, Standard Practices).

C. Remove or loosen engine-dressing items as necessary to gain access to the blanking plugs on the HP compressor casing.

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BS0003038/2





FORWARD

STAGE 5 STAGE 4 STAGE 3 STAGE 2 STAGE 1

STAGE 6

STAGE 7

INSPECTION PORT LOCATIONS AT A

RETAINING PLATE

BLANKING PLUG

STAGES 1 AND 2

STAGE 7 (ALTERNATIVE)

STAGE 4 (ALTERNATIVE)

BLANKING PLUG

WASHER

STAGES 5 AND 6

BLANKING PLUG

LOCKNUT

BLANKING PLUG

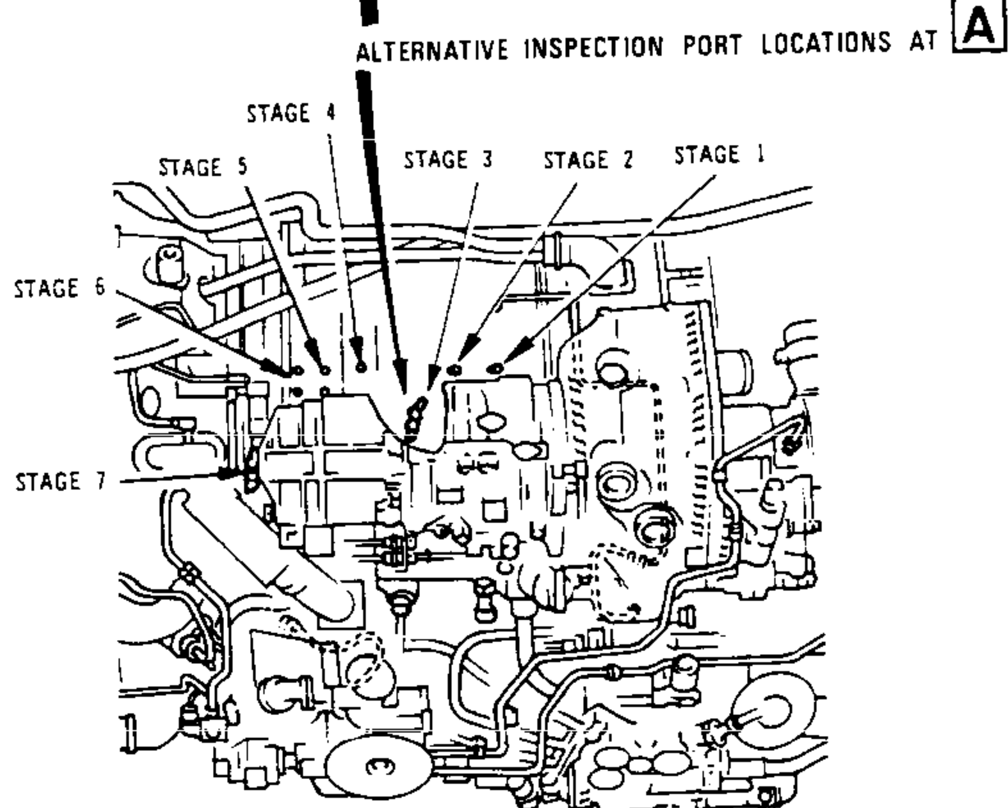
STAGE 3

HP Compressor Casing - Right-Hand Side Inspection Port Locations
Figure 802 (Sheet 1 of 2)

CR 33532/00A

STAGE 3
STAGE 5
STAGE 4
STAGE 2
STAGE 1
STAGE 6
STAGE 7

ALTERNATIVE INSPECTION PORT LOCATIONS AT A



HP Compressor Casing - Right-Hand Side Inspection Port Locations
Figure 802 (Sheet 2 of 2)

CR 31134/00C
BS00030384/6

A

RETAINING PLATE

BLANKING PLUG

STAGES 1 AND 2

STAGE 4 (ALTERNATIVE)

STAGE 1 STAGE 2 STAGE 3

STAGE 4

STAGE 5

STAGE 6

INSPECTION PORT LOCATIONS AT A

LOCKNUT

BLANKING PLUG

WASHER

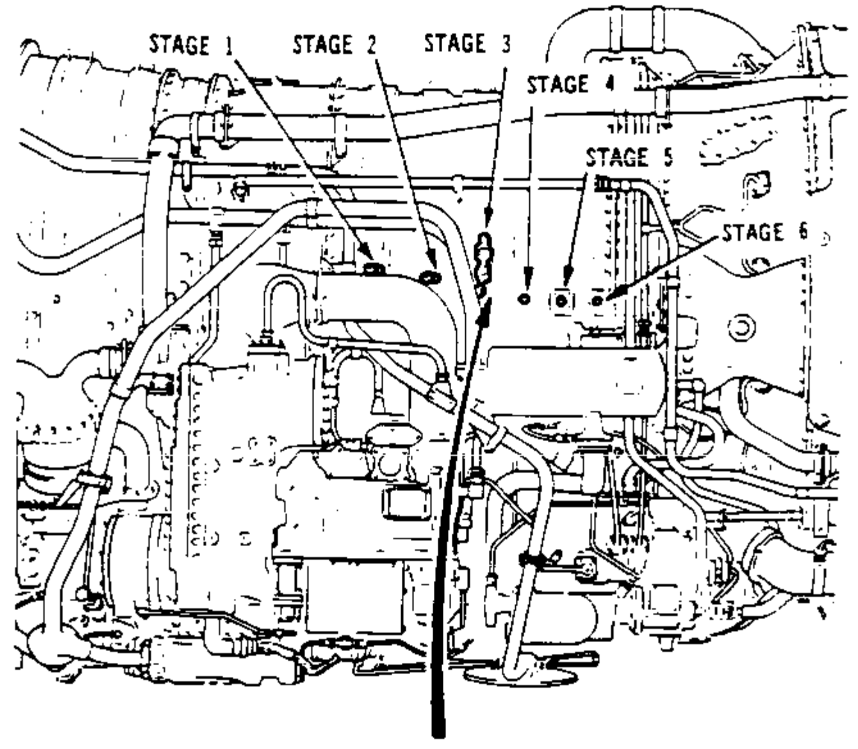
BLANKING PLUG

STAGE 3

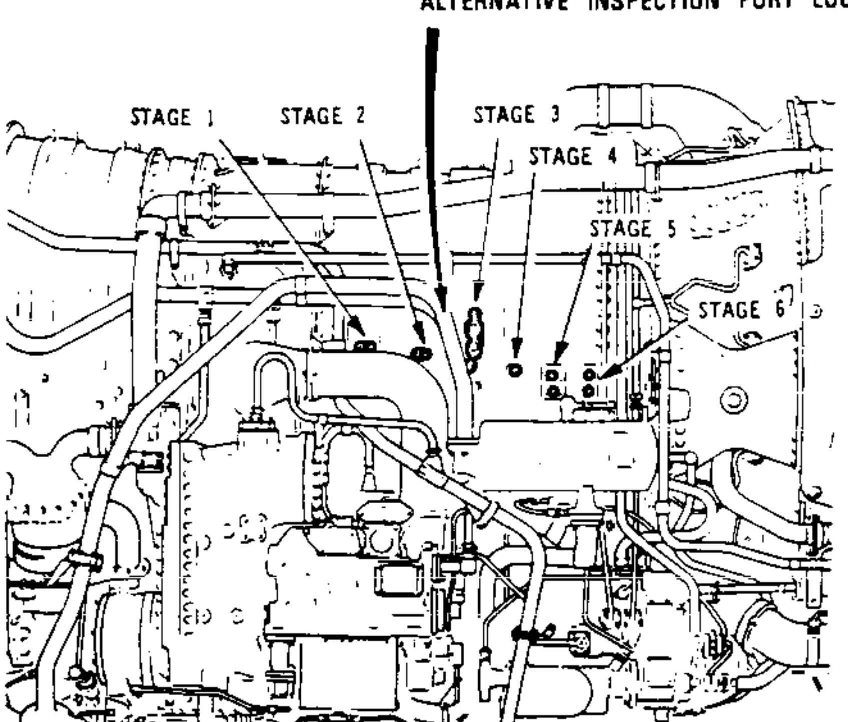
STAGES 5 AND 6

HP Compressor Casing - Left-Hand Side Inspection Port Locations
Figure 803 (Sheet 1 of 2)

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HP Compressor Casing - Left-Hand Side Inspection Port Locations
Figure 803 (Sheet 2 of 2)

D. Remove the appropriate blanking plug from the HP compressor casing (Ref. Fig. 802 and 803).

<u>NOTE:</u> It may be necessary to remove the probe mounting block at stages 3, 4 and 7 to gain better access, it should be noted that this may result in the shearing of the bolts in the compressor casing. If this occurs, refer to the Rolls-Royce, Olympus 593 Project Office, Filton, Bristol, for corrective action.

6. In-Situ Blade Blending Procedures

A. In-situ blending of Stage 1-7 HP Rotor Blades using Blade Blending Kit (Ref. Figs. 804, 805, 806, 807, 808, 809, 810 and 811).

(1) General tool selection and operation

(a) Select the appropriate cutter according to which stage and area of blade requires blending (Ref. Fig. 801).

<u>NOTE:</u> The tools are listed as a guide only, operators may choose to use a different length cutter or polisher to that specified for a certain stage.

(b) Information regarding the sizes and type of blade material are given in Table 802 - HP Compressor Rotor Blade Information, to further assist in the cutter selection.

(c) The blade blending kit may be used on its own or in conjunction with a CCD camera attachment and TV monitor.

DESCRIPTION	MATERIAL	QTY	MAX WIDTH		AEROFOIL LENGTH	
			*INCH	MM	INCH	MM
STAGE 1	Titanium	34	3.50	88,0	7.00	178,0
STAGE 2	Titanium	54	2.40	60,0	6.50	165,0
STAGE 3	Titanium	55	2.00	51,0	5.00	127,0
STAGE 4	Nimonic	69	1.90	47,0	4.00	102,0
STAGE 5	Nimonic	81	1.80	45,0	3.50	89,0

DESCRIPTION	MATERIAL	QTY	MAX WIDTH		AEROFOIL LENGTH	
			*INCH	MM	INCH	MM
STAGE 6	Nimonic	83	1.80	45,0	3.00	76,0
STAGE 7	Nimonic	105	1.50	38,0	2.50	64,0

* ROUNDED FIGURES

Table 802 - HP Compressor Rotor Blade Information

(d) The comparator is installed in the tool head and used in place of a cutter to inspect and assess the extent of the damaged blade (Ref. Fig.804).

(e) It is recommended that a large diameter borescope is used periodically instead of the blending kit borescope for inspection of the blend, this will enable a clearer view of the blend.

(2) Procedure (Ref. Figs. 804, 805 and 806)

CAUTION: THE HP COMPRESSOR ROTOR MUST BE LOCKED BEFORE ATTEMPTING ANY MEASUREMENT OR REPAIRS.

(a) Lock the HP compressor rotor in the required position using the adapter and immobiliser. Due to the geometry of the HP blades, it may be necessary to unlock, rotate and re-lock the HP compressor rotor to obtain the optimum position for blending (Ref. Fig.805).

(b) Assess the extent and depth of the damaged blade using the comparator (Ref. Fig.804).

NOTE: This procedure should be carried out by two separate skilled operatives to ensure an accurate assessment.

(c) Assess the suitability for repair in accordance with paras. 7 and 8.

CAUTION: THE CUTTER IS LOCATED IN THE HEAD USING A TWIN SCREW THREAD. BEFORE USING THE BLADE BLENDING TOOL, ENSURE THAT THE CUTTER IS LOCATED CORRECTLY IN THE HEAD. THERE SHOULD BE NO GAP BETWEEN THE CUTTER SHANK AND THE TOOL HEAD.

CAUTION: BEFORE USE, ENSURE THAT THE DIRECTION OF CUTTER ROTATION IS CORRECT. WHEN VIEWED FROM ABOVE, THE TOOL MUST ROTATE ANTI-CLOCKWISE.

CAUTION: BEFORE USE, ENSURE THAT THE BORESCOPE, IS CORRECTLY LOCKED IN THE TOOL.

(d) Select and install the appropriate cutter in the tool head (Ref. para. 6.B.(1)).

(e) Straighten the tool head and insert the blending scope through the inspection port.

CAUTION: DO NOT SWITCH THE CUTTER ON BEFORE ARTICULATING THE TOOL HEAD. THIS WILL RESULT IN THE DISENGAGEMENT OF THE CUTTER DRIVE BELT.

(f) Articulate the tool head through approximately 90 degrees, visually check the cutter position in relation to the blade, then switch on and select a high-speed setting.

NOTE: The operating range of the tool is between 80 - 100 degrees. The tool will not operate when the tool head is articulated outside of this range.

CAUTION: DURING BLENDING OPERATIONS, CARE MUST BE TAKEN TO AVOID TOOL HEAD AND SHANK CONTACT WITH ADJACENT BLADES.

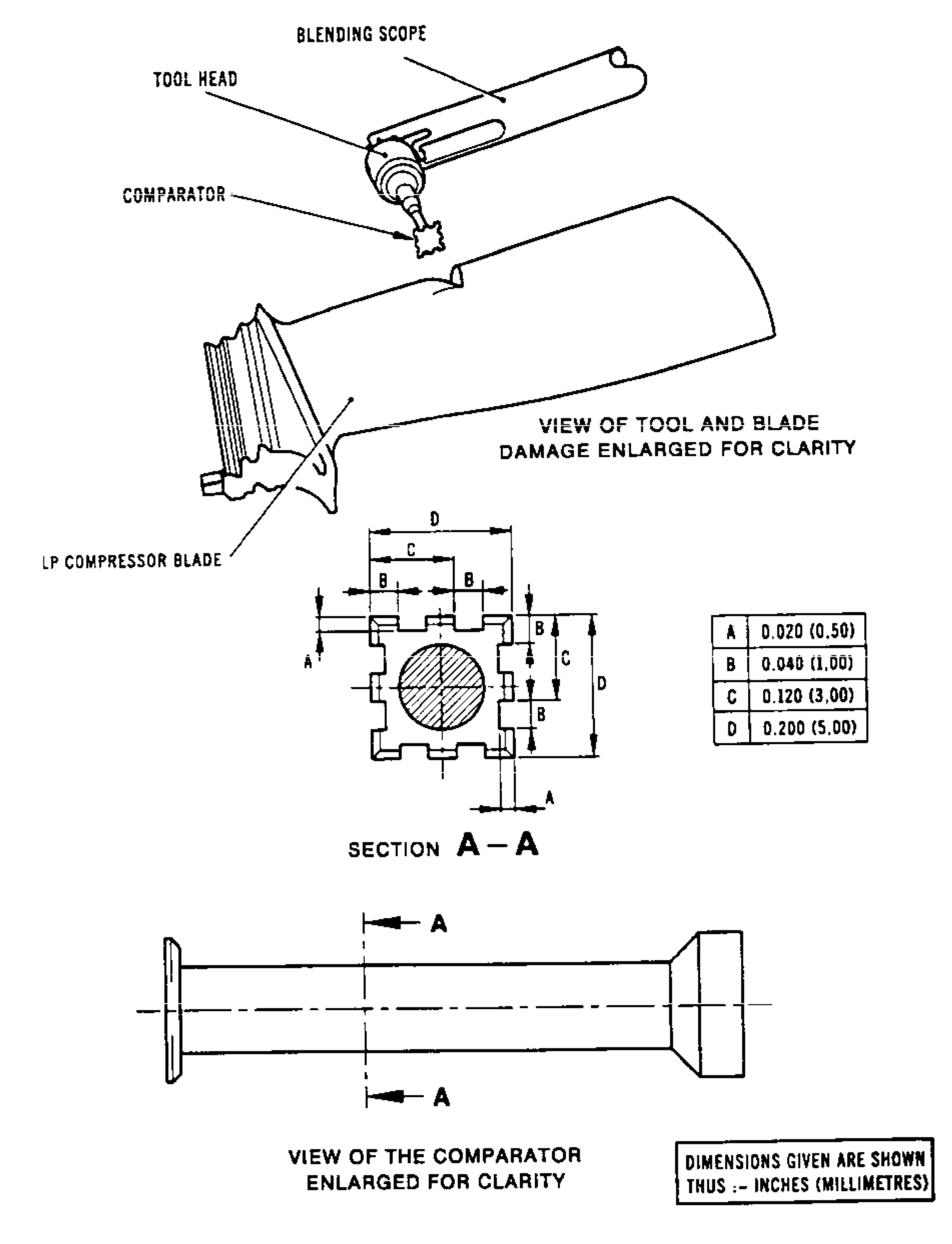
(g) Carry out roughing cuts to remove damage.

NOTE: If too much pressure is applied to the tool, the cutter may stop due to belt slippage. If this happens carefully release the pressure and resume cutting.

(h) Switch off the cutter, articulate the tool head straight and withdraw the blending scope from the engine.

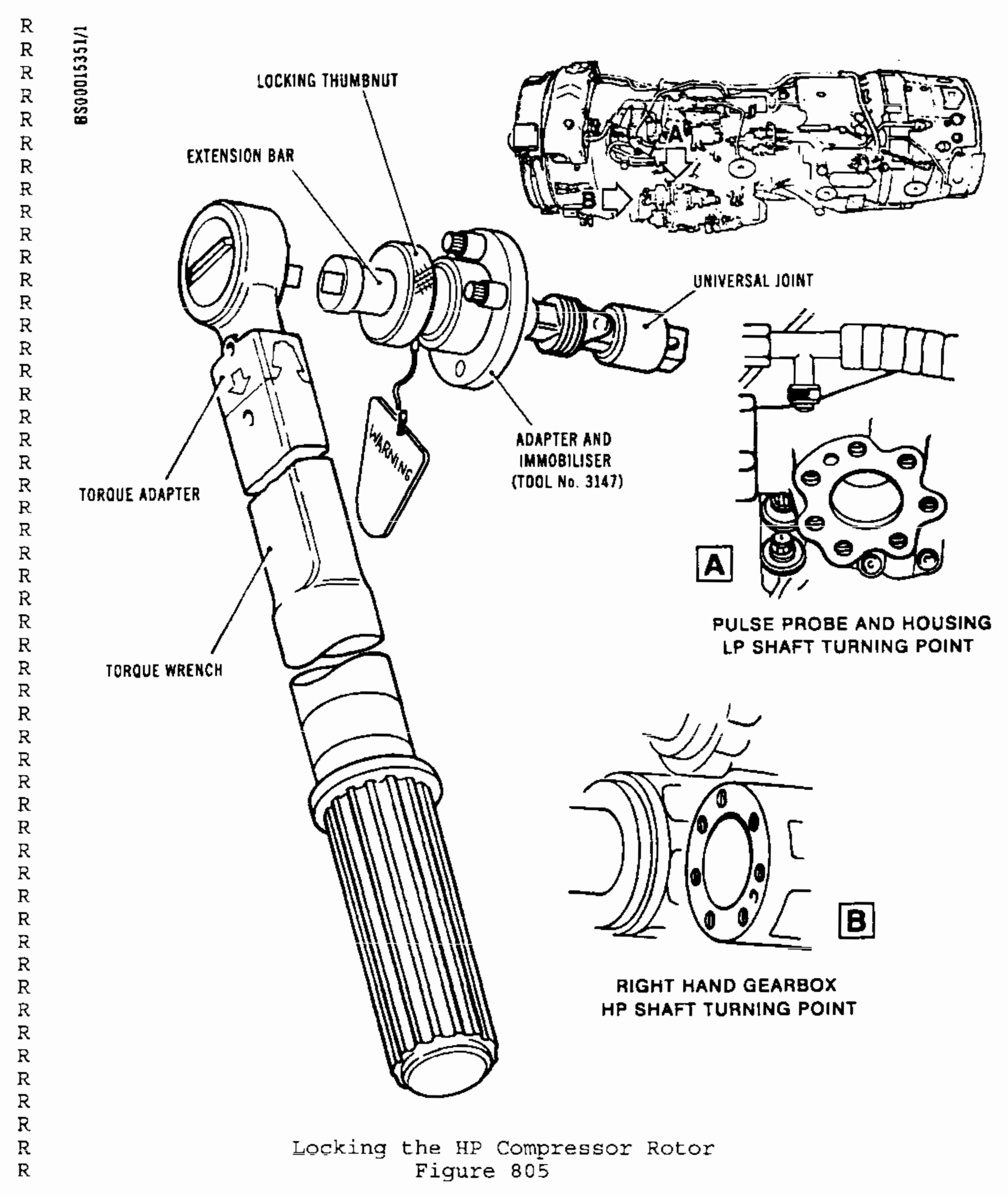
(i) Remove the cutter from the tool head. Select and install a radius cutter (Ref. Para. 6.B.(1)).

(j) Straighten the tool head and insert the blending scope through the inspection port.



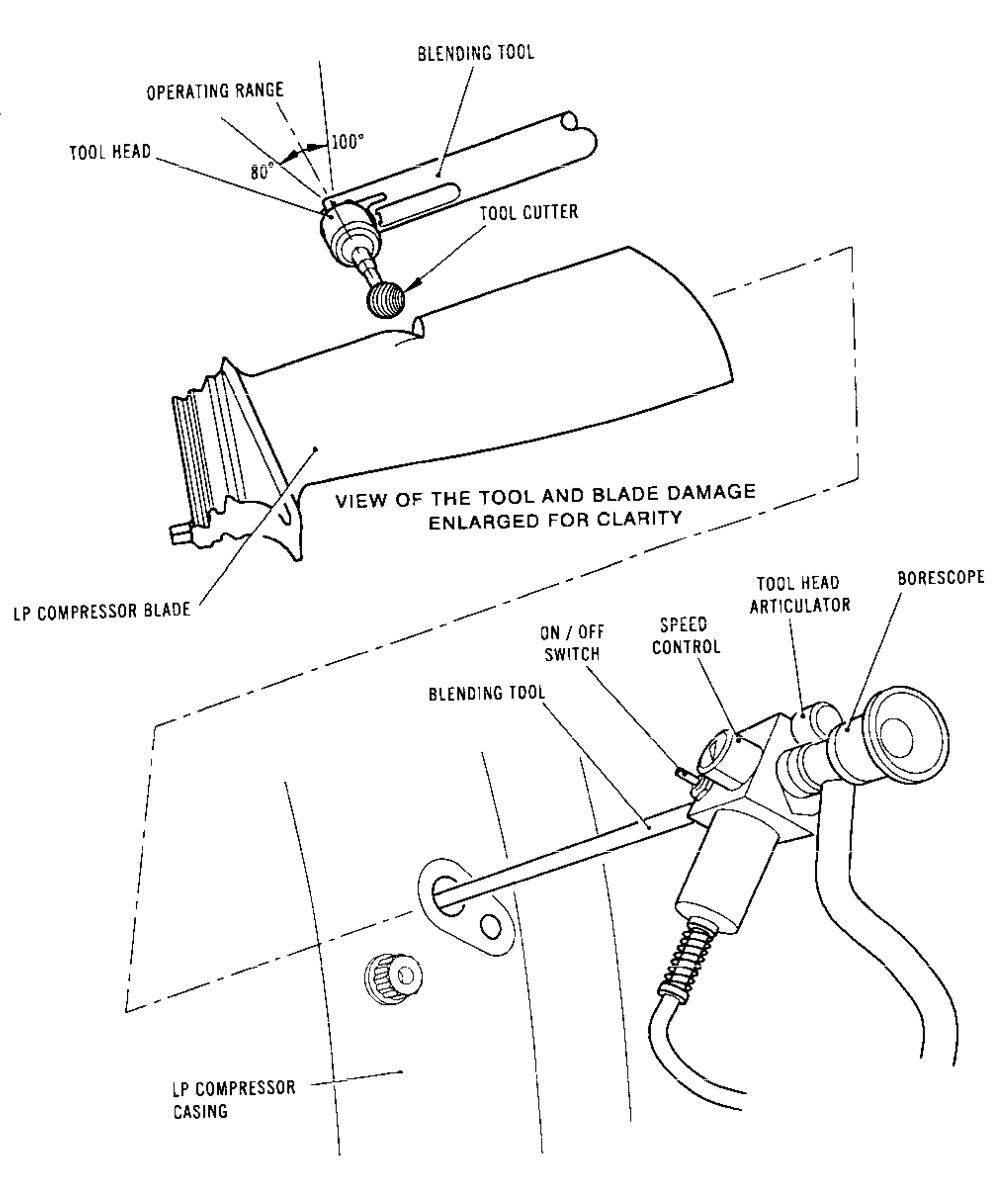
A	0.020 (0.50)
B	0.040 (1.00)
C	0.120 (3.00)
D	0.200 (5.00)

Measurement and assessment of Damaged Blades
Figure 804



Locking the HP Compressor Rotor
Figure 805

R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R R



In-Situ Blade Blending Tool
Figure 806

CAUTION: DO NOT SWITCH THE CUTTER ON BEFORE ARTICULATING THE TOOL HEAD. THIS WILL RESULT IN THE LOSS OF THE CUTTER DRIVE BELT.

(k) Articulate the tool head through approximately 90 degrees, visually check the cutter position in relation to the blade, then switch on and select a high-speed setting.

NOTE: The operating range of the tool is between 80 - 100 degrees. The tool will not operate when the tool head is articulated outside of this range.

CAUTION: DURING BLENDING OPERATIONS, CARE MUST BE TAKEN TO AVOID TOOL HEAD AND SHANK CONTACT WITH ADJACENT BLADES.

(l) Carry out radius cutting.

NOTE: If too much pressure is applied to the tool, the cutter may stop due to belt slippage. If this happens carefully release the pressure and resume cutting.

(m) Switch off the cutter, articulate the tool head straight and withdraw the blending scope from the engine.

(n) Remove the cutter from the tool head. Select and install a polisher (Ref. para. 6.B.(1)).

(o) Straighten the tool head and insert the blending scope through the inspection port.

CAUTION: DO NOT SWITCH THE CUTTER ON BEFORE ARTICULATING THE TOOL HEAD. THIS WILL RESULT IN THE LOSS OF THE CUTTER DRIVE BELT.

(p) Articulate the tool head through approximately 90 degrees, visually check the cutter position in relation to the blade, then switch on and select a high-speed setting.

NOTE: The operating range of the tool is between 80 - 100 degrees. The tool will not operate when the tool head is articulated outside of this range.

CAUTION: DURING BLENDING OPERATIONS, CARE MUST BE TAKEN TO AVOID TOOL HEAD AND SHANK CONTACT WITH ADJACENT BLADES.

(q) Carry out finish polishing.

NOTE: If too much pressure is applied to the tool, the cutter may stop due to belt slippage. If this happens carefully release the pressure and resume polishing.

(r) Switch off the polisher, articulate the tool head straight and withdraw the blending scope from the engine.

(s) Remove the polisher from the tool head. Install comparator.

(t) Inspect and measure the blend using the comparator (Ref. Fig. 804).

R (u) Record details of the repair.

R (3) Remove in-situ blade blending equipment.

R (a) On completion of in-situ blade blending repair,
R remove blending tool from the engine.

R (b) Ensure that the power supply is switched OFF,
R then disconnect power unit.

R (c) Dismantle in-situ blade blending equipment and
R stow in the appropriate storage containers.

R (d) Remove the HP compressor turning equipment
R (Ref. 72-09-01, Engine Turning).

R (4) Blending repair limits (Ref. Figs.807, 808, 809, 810 and 811)

(a) Blend torn, rough or scored edges to depth 20 per cent greater than the depth of damage measured using the comparator (Ref. Fig.804) provided that specified limits are not exceeded.

(b) If blends interfere, metal must be removed to produce a coupled blend.

(c) Blends must be smoothly profiled into the aerofoil shape. Leading and trailing edges should be blended into a radius and should not leave a knife-edge.

(d) Polish all blends and defective areas to achieve a good surface finish with no machining marks.

(e) Remove only the minimum amount of material consistent with specified requirements and dimensions.

(f) In Zone X, the maximum blend depth is limited to 0.010 in (0.25 mm) maximum.

(g) For opposing blends the chordal width must not be reduced by more than dimension A.

(h) The blending and polishing of marks is acceptable only in a radial direction, from root to tip. Some residual post blending MINOR marking around the blend is acceptable.

7. Assessment of Amount of Blending per Blade (All Stages)

A. Blades may be blended in several positions provided that the total extent of blending is not more than the equivalent of two blends in the maximum Zone Z.

B. The depth of blending is controlled by the zonal location of the damage.

C. The maximum permissible number of blended blades per stage, when blended to maximum limits is identified as L on the illustration

D. Where blades are not blended to the permissible maximum, this number (Ref. Para.C.) may be increased, provided that the aggregate of the blending does not exceed L.

E. Permissible blending is controlled by depths e.g. Stage 1 blade.

(1) 0.150 in (3,81 mm) depth x two blends = 0.300 in (7,62 mm) total = maximum blended blade.

(2) This maximum may be obtained as defined in (a) or (b), or by any combination of depths the total of which does not exceed 0.300 in (7,62 mm).

(a) 0.100 in (2,54 mm) depth x three blends.

(b) 0.075 in (1,90 mm) depth x four blends.

F. One coupled blend = two blends.

G. Dimension D blend = one blend.

H. Dimension E blend = half blend (depth assessed as RADIUS divided by 2).

8. Assessment of Blending Equivalent to L Number of Blended Blades Per Stage

A. Example for Stage 1 blade.

(1) L = three blades x 0.300 in (7,62 mm) depth = 0.900 in (22,86 mm) aggregate depth.

(2) This aggregate may be obtained as defined in (a) or (b), or by any aggregate of blended blades which does not exceed 0.900 in (22,86 mm).

(a) 0.180 in (4,57 mm) depth x five blades.

(b) 0.150 in (3,81 mm) depth x six blades.

R 9. Install Blanking Plugs and Engine-Dressing Items

R A. Assemble all blanking plugs removed to gain access to
R the HP compressor rotor blades (Ref. 72-33-00, Inspection/
R Check).

R B. Assemble and secure all engine-dressing items removed or
R loosened to gain access to the HP compressor casing
R blanking plugs.

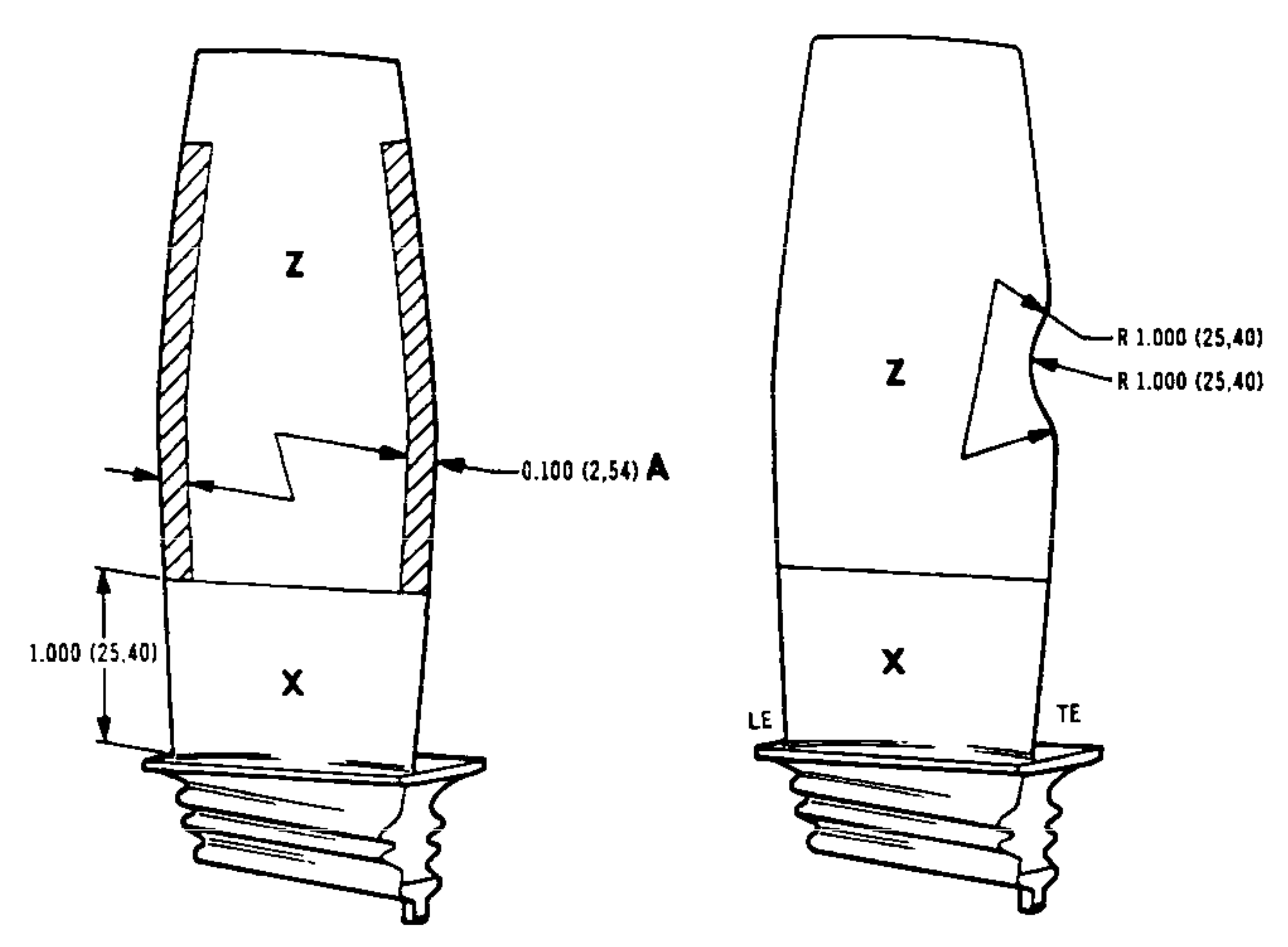
R 10. Conclusion

A. On completion of work close the engine bay doors (Ref. 71-00-00, Servicing).

R B. Ensure repair details are recorded.

C. A post repair inspection should be carried out after 10 flight hours and then again at the next S inspection at 230 hours. (Ref. 72-09-03, Inspection/Check).

D. Rolls Royce Limited/SNECMA reserve the right to amend all or part of the acceptance standards stated in this repair procedure, as engine operational experience, with damaged blades, is gained.



IN ZONE X, EDGE BLENDS 0.010 (0,25) DEEP MAX. PERMITTED WITH BLEND RADII AS FOR ZONE Z.

L - MAXIMUM NUMBER OF BLADES BLENDED TO MAXIMUM = 3.

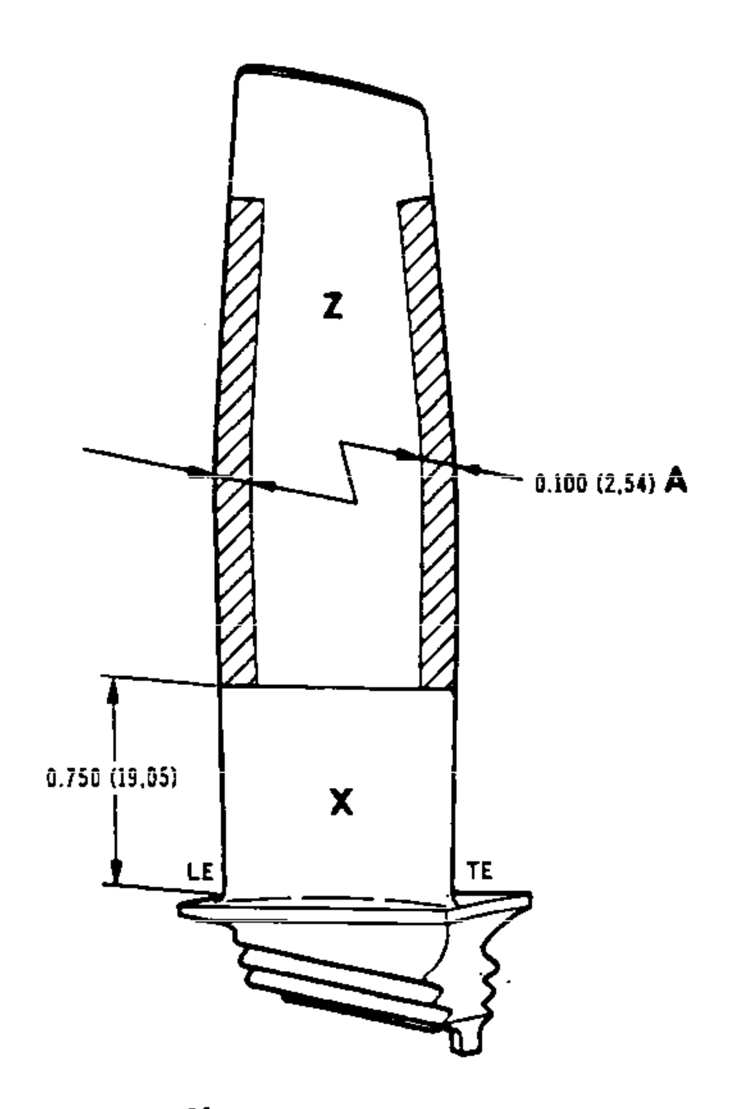
DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)

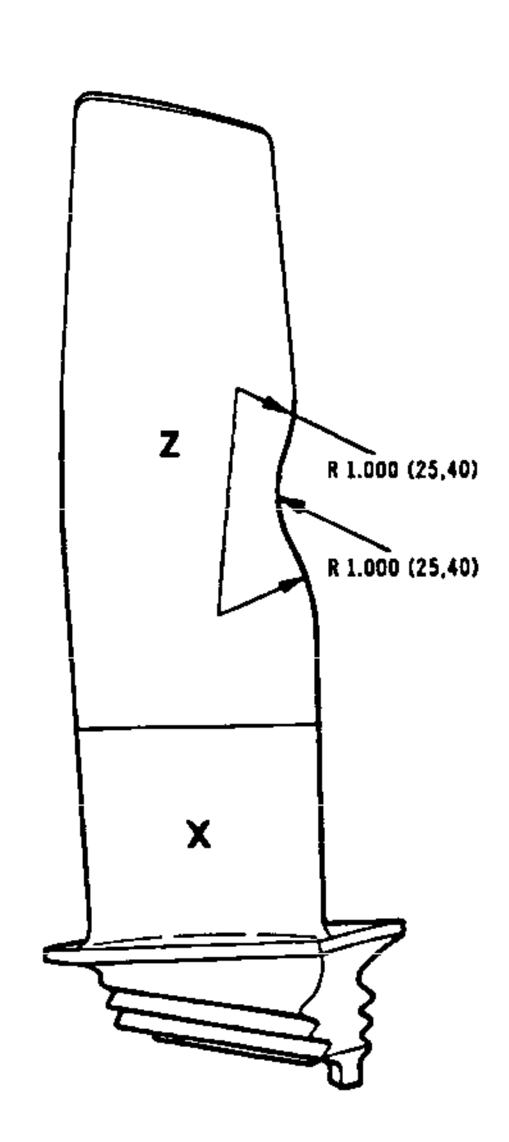
Stage 1 HP Rotor Blade - In-Situ Blending Standard
Figure 807

BS0015361/1

RADII TO BLEND SMOOTHLY INTO AEROFOIL SHAPE

BLENDING INSTRUCTIONS APPLICABLE TO ALL STAGES





IN ZONE **X**, EDGE BLENDS 0.010 (0,25) DEEP MAX. PERMITTED WITH BLEND RADII AS FOR ZONE **Z**.

L - MAXIMUM NUMBER OF BLADES BLENDED TO MAXIMUM = 5.

DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)

Stage 2 HP Rotor Blade - In-Situ Blending Standard
Figure 808

BS0015363/1

Stage 3 and 4 HP Rotor Blades - In-Situ Blending Standard
Figure 809

BS00015362/1

RADII TO BLEND SMOOTHLY INTO AEROFOIL SHAPE

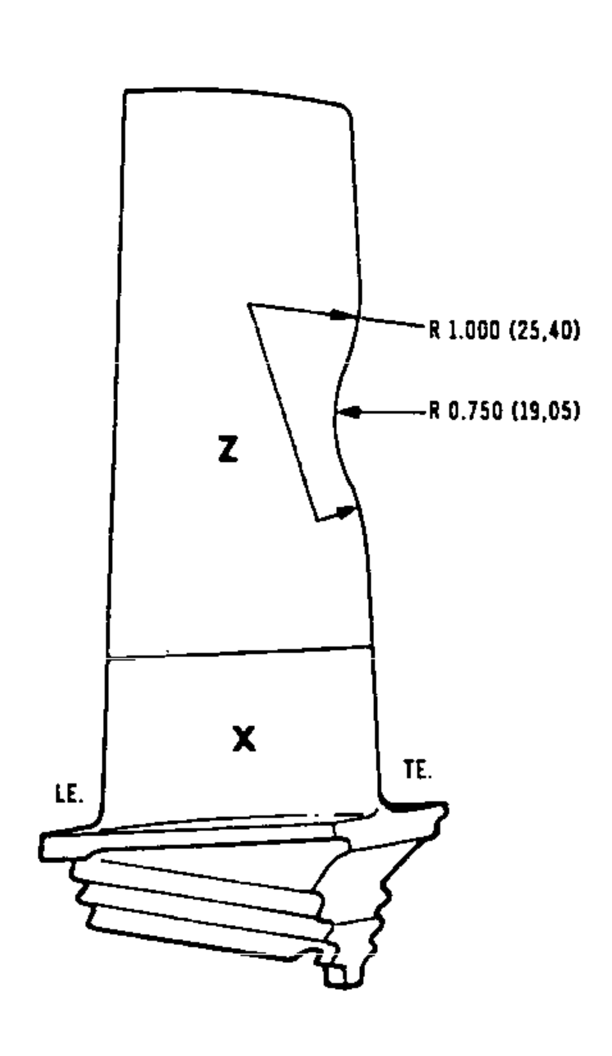
BLENDING INSTRUCTIONS APPLICABLE TO ALL STAGES

Z

0.080 (2,03) A

0.750 (19,05)

X



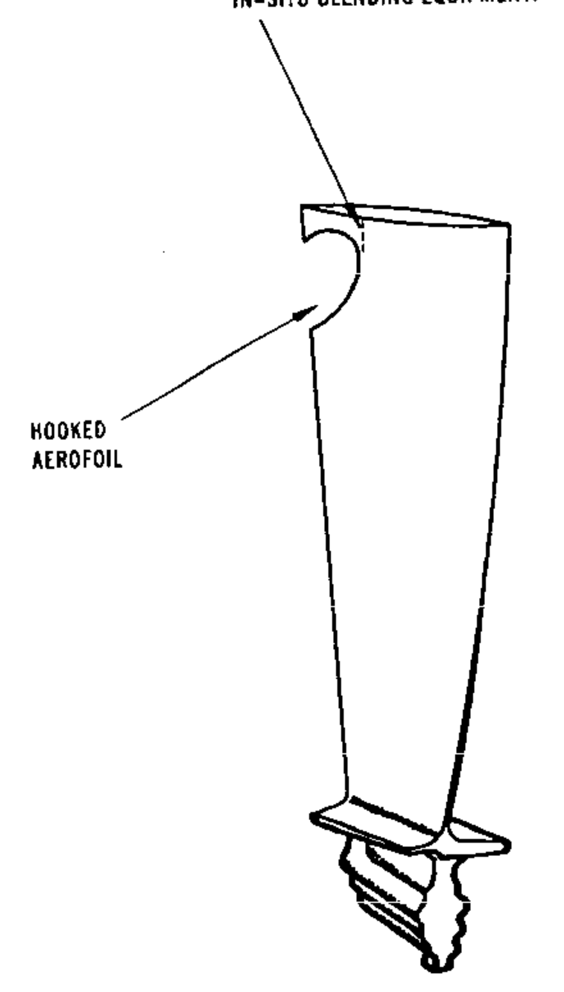
IN ZONE X, EDGE BLENDS 0.010 (0,25) DEEP MAX., PERMITTED WITH BLEND RADII AS FOR ZONE Z.

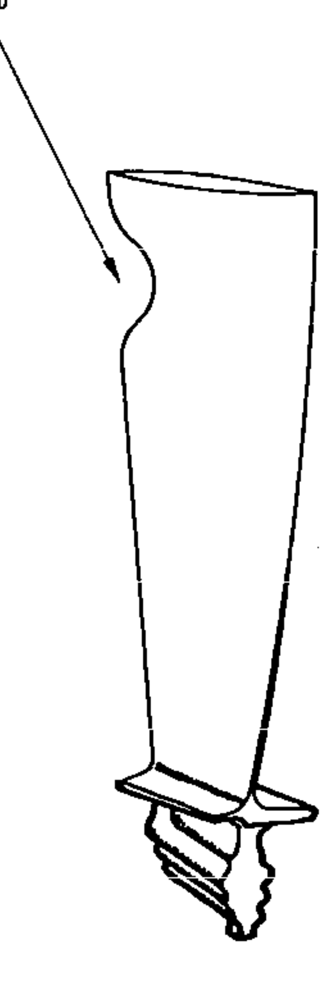
L - MAXIMUM NUMBER OF BLADES BLENDED TO MAXIMUM = 8 FOR STAGE 5.
8 FOR STAGE 6.
10 FOR STAGE 7.

DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)

Stage 5, 6 and 7 HP Rotor Blades - In-Situ Blending Standard
Figure 810

BS0015364/1





Hooked Blades
Figure 811

HIGH PRESSURE COMPRESSOR DIFFUSER CASE ASSEMBLY
DESCRIPTION AND OPERATION

1. General (Ref. Fig. 001)

The high pressure compressor diffuser case assembly is located between the HP compressor case and the combustion chamber outer case.

2. Description

The diffuser case consists of an inner and outer case bridged by eight hollow vanes numbered in a clockwise direction viewed from the rear with No.1 vane at the top. The vanes house air and oil transfer tubes which provide engine and aircraft services as follows:

No.1 vane - turbine cooling air, No.2 and 8 vanes, aircraft air conditioning and primary nozzle control air, No.3 vane - HP turbine bearing cooling air, No.4 vane - HP turbine cooling air; No.5 vane - HP turbine bearing oil feed, oil scavenge and air venting; No.6 vane - compressor labyrinth vent; No.7 vane - fuel heating air supply.

A junction box, bolted to the outer case at No.5 vane, provides for the connection of the external tubes associated with the tubes housed in the vane.

R Sixteen fuel pressure atomizing nozzle assemblies, bolted to
R the outer case extend through the case and protrude in the
R combustion section. The engine mounting trunnions are
R located, one on each side of the outer case, at the engine
R horizontal centre line.

OUTER CASE
COMBUSTION CHAMBER OUTER CASE
FUEL ATOMIZING NOZZLE
COMBUSTION CHAMBER
INNER CASE
ENGINE MOUNTING TRUNNION
OIL FEED TUBE
HP TURBINE BEARING AIR VENT TUBE
JUNCTION BOX
OIL SCAVENGE TUBE
CR 30434/00B
CMR 72 34 00 0 AAM0

VANE 1
2
3
4
5
6
7
8

VIEW LOOKING FORWARD
SHOWING VANE NUMBERING

R Diffuser Case Assembly
Figure 001

COMBUSTION SECTION - DESCRIPTION AND OPERATION

1. Description

The engine combustion section is located between the HP compressor diffuser case and the HP turbine assembly of the turbine section as shown in Figure 1. This section consists of a combustion chamber outer case with an annular type combustion chamber located in the annulus formed between the outer case and the outer surface of the HP turbine bearing front support. The outer case also encloses the HP turbine assembly and LP turbine nozzles. The combustion section is enclosed by heat shields, which are supported by the outer case.

The combustion chamber outer case is bolted to the diffuser case from which the nozzles of the fuel pressure atomizing nozzle assemblies protrude into the combustion section. At the bottom centre and bottom right of the outer case, mounting locations are provided for each fuel pressure atomizing (pilot) nozzle and its igniter plug. Blanked ports in the outer case enable a borescope to be inserted for an internal examination of the combustion section to be carried out.

The annular combustion chamber has a head assembly joining an inner and an outer barrel that are built-up from combustion sections and cooling rings and terminate in inner and outer mounting flanges. The head assembly has an inner and outer row of holes at its rear and 16 holes in its front face. A vaporiser is mounted and secured with a retaining nut at each of the front face holes. Each vaporiser body has two weirs at the rear and ducts located behind the weirs have convergent outlets facing forward and parallel to the sides of the combustion chamber.

The combustion sections that form the barrels have primary, intermediate and dilution air ports directed inward to the combustion zone.

The inner and outer flanges support the combustion chamber at the rear. The inner flange, positioned by assembly pins, is bolted to the nozzle support cone. The outer flange is secured between the rear of the HP turbine nozzles and the front of the nozzle vane abutment segments.

CR 30436/00D
BS00027333/1

RETAINING NUT
HEAD ASSEMBLY
FUEL ATOMIZING NOZZLE
WEIR
DUCT
A

B
B

HP COMPRESSOR DIFFUSER CASE
COMBUSTION CHAMBER OUTER CASE
HEAT SHIELD
OUTER BARREL
FLANGES
FUEL ATOMIZING NOZZLE
VAPORISER
HEAD ASSEMBLY
FRONT BEARING SUPPORT ASSEMBLY
INNER BARREL
NOZZLE VANE CONE SUPPORT
HP TURBINE NOZZLE VANE

OUTER BARREL
IGNITER PLUG
COMBUSTION CHAMBER OUTER CASE
PILOT ATOMIZING NOZZLE
C

C
C
SECTION B – B

Combustion Section
Figure 1

CR 31366/00C
BS00027334/1

PRIMARY AIR
INTERMEDIATE AIR
DILUTION AIR
COOLING AIR

Combustion Section - Air Flow
Figure 2

2. Operation (Ref.Fig.2).

Air from the compressors enters the combustion section via the HP compressor diffuser case assembly. A small proportion of this air enters the combustion chamber by way of the vaporisers where the metered fuel from the fuel atomizing nozzles is introduced.

The air entering the vaporiser carries the vaporising fuel spray rearwards between the weirs and then into the duct. The duct directs the flow forward against the front fairing of the head assembly at which stage fuel vaporisation is completed. The action of the weirs eliminates hot-spots on the ducts.

The bulk of the air passes rearwards around the outside of the chamber. Air entering the holes in the head assembly combines with air entering the primary ports and provides a recirculation air flow at the front of the combustion chamber which mixes with the fuel vapour to form a stable primary combustion zone. Air passing through the intermediate ports provides for a secondary combustion and air from the dilution ports ensures a uniform temperature of the gasses at the outlet to the HP turbine nozzles. Cooling air, from the bulk air flow, is directed by the cooling rings to form a cooling layer along the inside of the chamber wall. The air remaining from the bulk flow is passed through the HP turbine nozzle guide vanes for cooling.

Combustion is initiated during the starting cycle by the pilot atomizing nozzles in conjunction with the high energy igniter plugs. Light-up is transmitted from the pilot atomizing nozzles to the starting fuel spray at the main fuel atomizing nozzles and vaporisation commences.

COMBUSTION CHAMBER - INSPECTION/CHECK

R COMPLETE RE-ISSUE

1. General

The combustion chamber, fuel vaporisers and high pressure (HP) turbine nozzle vane leading edges are examined by use of an optical inspection instrument inserted through each of three inspection ports provided in the combustion chamber outer case (CCOC). Access to the right-hand inspection port of engines installed in No.1 and No.3 positions will necessitate removal of the four-way air starting duct.

Paragraph 7. details the acceptance standards applicable to combustion chambers.

The combustion chamber has been divided into sub-sections as follows to facilitate the assessment of damage found to the limits of acceptance given in paragraph 7.

FUEL VAPORISERS
HEAD ASSEMBLY
INNER AND OUTER BARRELS
TURBINE ENTRY DUCT REGIONS

When damage to the combustion chamber sub-sections is found, it may be necessary to inspect other areas for secondary damage. Details of these damage monitoring checks are given in paragraph 8.

A. Read the following information regarding the use of borescope equipment. This outlines how these may affect safety and their classification relative to our Procedures. The precautions listed <u>must</u> be complied with.

(1) <u>Background and Description</u>

Borescope inspections of internal engine components are frequently carried out. These inspections, when conducted with equipment utilising a light source box, now require additional precautions to be taken to eliminate risk of hazard when used in an environment potentially containing combustible gases.

Engines installed or near an aircraft, inside or outside a hangar, fall within the compass of this environment. Uninstalled engines in workshops may also be in a hazardous environment.

These environments are termed "Zone 2" areas but dedicated Zone 2 certification for equipment is not granted by the Regulatory Authority and it is deemed "UNCERTIFIED EQUIPMENT".

A borescope kit comprises of several pieces of equipment but it is <u>only</u> the high intensity light source box which is of concern. Existing boxes (Uncertified Equipment) display a warning notice stating it must not be used in the presence of combustible gases.

Conditions of use of such equipment in a Zone 2 area in strict accordance with procedures (i.e. using gas monitors, etc.) would impose a considerable maintenance/operational burden.

An acceptable relaxation of this situation has been agreed following consultation/borescope demonstration with the Fire Protection Department; although relaxed, adequate safety standards and legal aspects are maintained provided the following precautions are adhered to.

(2) <u>Engines, Installed or Near an Aircraft</u>

(a) Check aircraft fuel log to ensure it has not uplifted a wide cut fuel (Jet B) during the previous 20 hours of operation.

B (b) Aircraft must not be transferring fuel.

B (c) Working inside aircraft fuel tanks must not be
B in progress.

B (d) Flammable Liquids with a flash point below 90°F
B (32°C) must not be used within the Remotely
B High Risk area - as defined in Section 5.2,
B EDP-P-FIRE 4.

B (e) Spraying or use of Petroleum Based Adhesives
B must not be permitted.

B (f) Liquid Petroleum Gases must not be used within
B the Remotely High Risk area.

B (g) If highly flammable liquids are present and
B "Uncertified Equipment" needs to be used or if
B any of the above conditions cannot be met, then
B Section 5.3 of EDP-P-FIRE 4 must be vigilantly
B followed.

B (h) Where applicable, Bonding must take place.

B (3) <u>Engines in Workshops</u>

B (a) Conditions (2)(d), (2)(e), (2)(f) and (2)(g)
B apply.

2. <u>Tools and Equipment</u>

Probe	) Part of kit) PE.24288	(PE.24004 (
Sleeve (retained on probe)...	)	(PE.24135
Probe	) Part of kit) PE.15889	(PE.15862 (
Transformer	)	(PE.24310
Probe eyepiece...		PE.15969
Light source box		PE.24304
Light transmitting cable ...	) Part of kit) PE.35891	(PE.24099 (
Probe		Keymed Olympus Kit 1F6D4-20

Guide Tube Kit...	S3S20081000
Comprising:	
Tube (1L)	S3S20081001
Tube (2L)	S3S20081010
Tube (3L)	S3S20081020
Tube (1R)	S3S20081030
Tube (2R)	S3S20081040
Tube (3R)	S3S20081050
Container	S3S20081060
Tube fixture (1L)	S3S20232000
Tube fixture (2L)	S3S20233000
Tube fixture (3L)	S3S20234000
Tube fixture (1R)	S3S20235000
Tube fixture (2R)	S3S20236000
Tube fixture (3R)	S3S20237000

3. Terminology for Damage

A. Apply the following definitions to the terms used to describe damage:

(1) Break. A separation by force into two or more pieces.

(2) Burn. Destructive oxidization usually caused by higher temperature than the parent material can withstand.

(3) Chip. A breaking away of the edge, corner or surface of the material.

(4) Crack. Visible partial separation of material which may progress to a complete break (Ref.(1)).

CR 33577/008

HP COMPRESSOR DIFFUSER CASE

COMBUSTION CHAMBER OUTER CASE

D

A

D

FORWARD

BLANKING COVER

BLANKING COVER

BLANKING COVER

GASKET

BLANKING PLUG

WASHER

A

B

C

D

SPACER PLATE
(PRE S.B. 72-62)

COMBUSTION CHAMBER
OUTER CASE

HP COMPRESSOR
DIFFUSER CASE

D

B

D

C

FORWARD

Inspection Port Locations
Figure 601

(5) Distortion. Excessive deformation of the original contour of the part, (associated terms, buckle, depression, twist, warp).

(6) Overheated. Subjected to excessive temperature usually evidenced by change in colour and appearance of part.

(7) Pierced. Puncture of the material.

(8) Spalled. Sharply roughened area characterised by progressive chipping away of the surface material.

4. Prepare Engine for Examination (Ref.Fig.601)

A. Open Engine Bay Doors.

(1) Open engine bay front and rear doors (Ref.71-00-00, Servicing).

B. Remove Blanking Covers from CCOC Inspection Ports.

(1) Remove attachment bolts and blanking cover from CCOC left-hand inspection port (Detail A).

(2) Remove attachment bolts and cover from right-hand inspection port together with spacer plate on engines to S.B.OL.593-72-8629-256 standard (Detail B).

NOTE: If difficulty was experienced in removal of bolts or cover, refer to S.B.OL.593-72-8629-256.

(3) Remove blanking cover from bottom inspection port (Detail C).

(a) Position a container to catch any residual fuel.

(b) Remove bolts securing blanking cover to CCOC.

(c) Withdraw blanking cover and gasket (S.B.OL.593-72-58) from engine.

(d) Wipe fuel deposits from inspection port area.

C. Prepare and Test Optical Inspection Equipment (Ref.72-09-03).

CR 35653/00A
BS00001738/2

OUTER BARREL

COMBUSTION CHAMBER OUTER CASING

FRONT FAIRING WITH VAPORISERS

INNER BARREL

16 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

ZONE H ZONE A ZONE B ZONE C ZONE D ZONE E ZONE F ZONE G

LEFT HAND PORT

RIGHT HAND PORT

LOWER PORT

DIAGRAMMATIC VIEW LOOKING FORWARD

DO NOT USE MARKING. IDENTIFY THE VAPORISERS BY THEIR RELATIVE LOCATIONS
ESTIMATE THE ZONE BOUNDARIES IN RESPECT OF THE VAPORISER

Theoretical Inspection Zones
Figure 602

5. Examination of Combustion Chamber (Ref.Fig.602 to 626)

A. General.

(1) Examination of internal surfaces.

The inspection probe is inserted through the inspection ports and adjacent cooling holes in the outer barrel to inspect the vaporisers and internal surfaces of the combustion chamber. To ensure full coverage of the surfaces, assess the combustion chamber by zones referenced to the vaporisers as shown in Figure 602. Marking is not to be used.

Insert the probes and manoeuvre within the limits of movement for depth and angle to cover the maximum area as shown in Figure 603. View every area from as many view points as possible to build a comprehensive picture. Record the zone and vaporisers as they are viewed so that, on completion of the inspection, full coverage can be confirmed.

(2) Examination of external surfaces.

The inspection probe is inserted through the inspection ports to view between the combustion chamber outer surface and the CCOC (Ref.Fig.609).

B. Examine Combustion Chamber Through CCOC Inspection Ports.

(1) Commence examination using probe PE.15862, in conjunction with transformer PE.24310, inserted through the CCOC ports.

WARNING: CHECK PERIODICALLY AND REMOVE RESIDUAL FUEL DRAINAGE AT LOWER PORT POSITION AND FROM PROBE. FUEL COULD ENTER EYES DURING EXAMINATION SEQUENCE.

QUARTZ IODINE BULBS MUST NOT BE HANDLED IN SERVICE. HANDLING OF BULB WILL CAUSE SURFACE CONTAMINATION WHICH MAY CAUSE BULB TO SHATTER.

CAUTION: DO NOT USE FORCE TO EFFECT PROBE ENTRY AND PREVENT PROBE FROM BECOMING DENTED OR BENT. INVESTIGATE ANY OBSTRUCTION TO PROBE PENETRATION.

CR 35654/00A
BS0001739/2

ZONE H
ZONE A
ZONE G
ZONE B
ZONE F
ZONE C
ZONE E
ZONE D
LH INSPECTION PORT
POSITION 2
POSITION 1

PROBE POSITION	VAPORISER LOCATIONS VISIBLE	BARREL ZONES VISIBLE	
1	1,2,3,9,10,11,12,13,14,15,16.	INNER	F (PART),G,H.
		OUTER	F,G,H.
❋ 2	4,5,6,7,8,9,10,11,12,13.	INNER	C,D.
		OUTER	A,B,C (PART), D,E,F (PART).

❋ POSITION 2 NOT POSSIBLE ON ENGINES INSTALLED IN No 2 AND 4 BAYS

Probe Insertion Angles and Range of Inspection
Figure 603 (Sheet 1 of 3)

CR 35655/00A
BS00026875/1

ZONE H ZONE A ZONE B ZONE C ZONE D ZONE E ZONE F ZONE G

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

BOTTOM INSPECTION PORT

POSITION 1

PROBE POSITION	VAPORISER LOCATIONS VISIBLE	BARREL ZONES VISIBLE	
1	1,6,7,8,9,10,11,12,13,14,15,16.	INNER	D,E,G.
		OUTER	E,F,G,H.

Probe Insertion Angles and Range of Inspection
Figure 603 (Sheet 2 of 3)

CR 35656/00A
BS0001740/2

ZONE A
ZONE B
ZONE C
ZONE D
ZONE E
ZONE F
ZONE G
ZONE H
RH INSPECTION PORT
POSITION 2
POSITION 1

PROBE POSITION	VAPORISER LOCATIONS VISIBLE	BARREL ZONES VISIBLE	
1	1,2,3,4,5,6,14,15,16.	INNER	A,B,C.
		OUTER	B (PART), C,H.
* 2	4,5,6,7,8,9,10,11,12,13.	INNER	E,F.
		OUTER	C (PART), D,E,F (PART), G,H.

* POSITION 2 NOT POSSIBLE ON ENGINES INSTALLED IN No 1 AND 3 BAYS

Probe Insertion Angles and Range of Inspection
Figure 603 (Sheet 3 of 3)

(a) Insert probe through inspection port, switch on probe illumination and commence examination of:

(i) The vaporisers and internal surfaces of the combustion chamber including the HP turbine nozzles.

(ii) The annulus between the combustion chamber outer surface and the CCOC (Ref. Fig.609).

(b) Record details of damage found.

(i) Record extent of any damage to the sub-sections using the terms given in paragraph 3. and by reference to Figures 602 to 626. If a photographic record of the damage is required, use the equipment and procedures detailed in 72-09-04.

NOTE: If the HP turbine Inspection/Check procedure (Ref.72-51-00) is to be carried out, phase it in with this sequence.

(ii) Record the approximate size and the position of any debris found in the annulus between the combustion chamber and the CCOC.

(c) On completion of examination switch off illumination and withdraw probe.

(d) Stow optical inspection equipment (Ref.72-09-03).

(e) Assess the acceptability of any damage found by comparison of the examination results with the acceptance standards stated in paragraph 7.

C. Examine No.2 Outer Cooling Ring Through CCOC Inspection Ports A and B (Ref. Fig.601) Using Guide Tubes.

CAUTION: WHEN REMOVING THE GUIDE TUBE FROM ITS FIXTURE, ENSURE IT IS INSTALLED CORRECTLY BEFORE REMOVAL AND THAT THE GUIDE TUBE PROFILE MATCHES EXACTLY THE PROFILE OF THE FIXTURE.

(1) Remove selected guide tube from its storage fixture.

CAUTION: USE NO FORCE TO INSERT GUIDE TUBES. ENSURE GUIDE TUBES ENTER THE COMBUSTION CHAMBER THROUGH THE CCOC PORT AND THE CORRECT CHAMBER PLUNGING AND DO NOT ENTER THE SPACE BETWEEN THE CCOC AND CHAMBER.

(2) Install selected guide tube to CCOC inspection port necessary to inspect the required cooling ring zone (Ref. Fig.604), using two slave bolts. Care must be taken to ensure the bolts do not inadvertently enter the inspection port and are not over-tightened.

NOTE: The two Air Starter Duct Tie Rods must be removed to enable installation of guide tube S3S20081030 in port B at engine positions 1 and 3.

CAUTION: ENSURE THE TIP OF THE PROBE IS STRAIGHT WHEN REMOVING THROUGH THE GUIDE TUBES TO AVOID DAMAGE.

(3) Install probe to light source, insert through guide tube and locate in No.2 cooling ring slot. Switch on probe illumination and commence examination of cooling ring. Remove probe.

NOTE 1: It may be necessary for a second operative to be employed during the probe inspection to hold the probe eye-piece whilst the first operative keeps radial pressure on the probe to keep it in position in the cooling hole slot.

NOTE 2: The operative may find it easier to feed-in the full amount of necessary probe through the guide tube and inspect whilst engaging backward movement.

NOTE 3: It is possible when fitting the longer guide tubes, to bolt in position and find that the cooling ring end is slightly out of position. In this event, loosen the slave bolts and slightly re-adjust the guide tube until probe is in correct position, then re-tighten slave bolts taking care not to over-tighten.

(4) Switch off illumination and withdraw probe from light source.

(5) Record details of any damage.

CAUTION 1: ENSURE ALL GUIDE TUBES REMOVED ON COMPLETION OF INSPECTION.

CAUTION 2: USE NO FORCE TO REMOVE GUIDE TUBES.

(6) Remove guide tubes from inspection ports.

CAUTION: WHEN INSTALLING GUIDE TUBE TO ITS FIXTURE, ENSURE IT IS INSTALLED CORRECTLY WITH THE TUBE PROFILE MATCHING THE FIXTURE PROFILE EXACTLY.

(7) Stow inspection equipment in its storage fixture.

(8) Assess the acceptability of any damage found by comparison of the examination results with the acceptance standards stated in para.7.

6. Install Blanking

A. Assemble Blanking Covers to CCOC Inspection Ports.

(1) Assemble blanking cover to the left-hand inspection port (detail A).

R CAUTION: IT IS ESSENTIAL THAT LUBRICANT 'C'
R IS USED ON THE APPLICABLE BOLTS/NUTS
R DURING ASSEMBLY.
R (REF. SB.OL.593-72-9044-436).

(a) Apply lubricant C to bolts (Ref. 70-00-01, Servicing and Storage Materials).

(b) Secure the blanking cover to the port with six bolts torque-tightened to 100 lbf in (11,5 Nm).

(c) Wire-lock the bolts together.

CR 36423/00A
BS00002462/2

OUTER BARREL
COMBUSTION CHAMBER OUTER CASING
FRONT FAIRING WITH VAPORISERS
INNER BARREL
ZONE 3L (SEE SHEET 7)
ZONE 3R (SEE SHEET 2)
PLUNGINGS
ZONE 2L (SEE SHEET 6)
ZONE 2R (SEE SHEET 3)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
LEFT HAND PORT
RIGHT HAND PORT
ZONE 1R (SEE SHEET 5)
ZONE 1L (SEE SHEET 4)
LOWER PORT

CAUTION: THE SHADED AREAS ARE DIAGRAMMATIC AND SHOW ONLY THE RADIAL DISTANCE OF THE INNER SURFACE OF THE No 2 OUTER COOLING RING TO BE INSPECTED.

DIAGRAMMATIC VIEW LOOKING FORWARD

ESTIMATE THE ZONE BOUNDARIES IN RESPECT OF THE PLUNGINGS
NO ZONE OVERLAP SHOWN

Probe Inspection of No.2 Outer Cooling Ring
using Guide Tubes
Figure 604 (Sheet 1 of 7)

CR 36417/00A
BS0002456/2

OUTER BARREL
COMBUSTION CHAMBER OUTER CASING
12.500 (APPROX) (317,50)
ZONE 3R
PLUNGINGS
INNER BARREL
16
1
2
15
3
14
4
13
5
12
6
11
7
10
9
8
LEFT HAND PORT
GUIDE TUBE S3S 20081050
RIGHT HAND PORT
FRONT FAIRING WITH VAPORISERS
LOWER PORT

CAUTION: THE SHADED AREAS ARE DIAGRAMMATIC AND SHOW ONLY THE RADIAL DISTANCE OF THE INNER SURFACE OF THE No 2 OUTER COOLING RING TO BE INSPECTED.

DIMENSION GIVEN ARE SHOWN THUS: INCHES (MILLIMETRES)

DIAGRAMMATIC VIEW LOOKING FORWARD
ESTIMATE THE ZONE BOUNDARIES IN RESPECT OF THE PLUNGINGS

Probe Inspection of No.2 Outer Cooling Ring using Guide Tubes
Figure 604 (Sheet 2 of 7)

CR 36418/00A
BSD0002457/2

Probe Inspection of No.2 Outer Cooling Ring
using Guide Tubes
Figure 604 (Sheet 3 of 7)

CR 36419/00B
BS00002458/3

OUTER BARREL
COMBUSTION CHAMBER OUTER CASING
FRONT FAIRING WITH VAPORISERS
INNER BARREL
PLUNGINGS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
LEFT HAND PORT
GUIDE TUBE S3S 20081001
RIGHT HAND PORT
ZONE 1L
LOWER PORT
40.000 (APPROX) (1016,00)

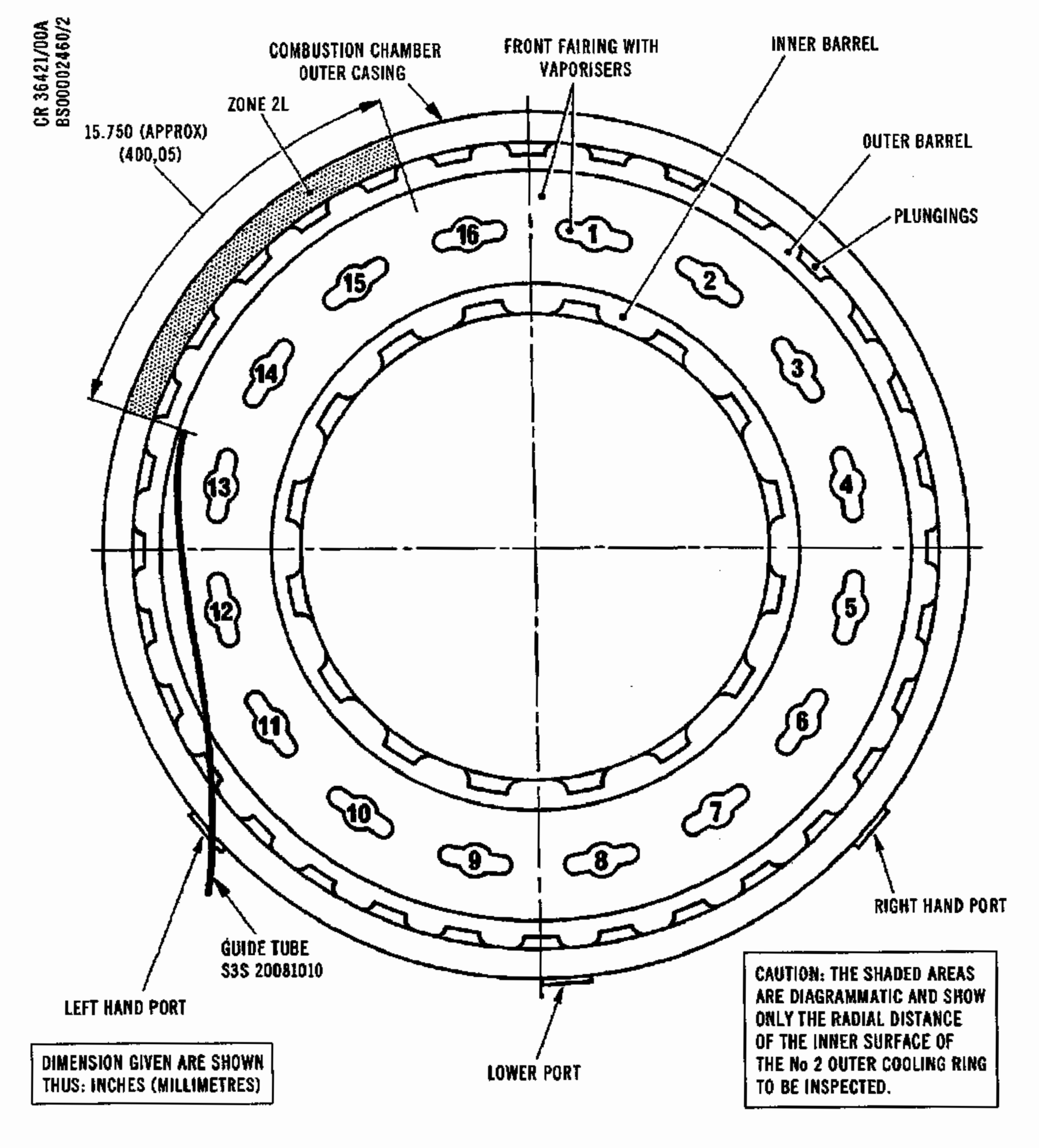
CAUTION: THE SHADED AREAS ARE DIAGRAMMATIC AND SHOW ONLY THE RADIAL DISTANCE OF THE INNER SURFACE OF THE No 2 OUTER COOLING RING TO BE INSPECTED.

DIMENSION GIVEN ARE SHOWN THUS: INCHES (MILLIMETRES)

DIAGRAMMATIC VIEW LOOKING FORWARD
ESTIMATE THE ZONE BOUNDARIES IN RESPECT OF THE PLUNGINGS

Probe Inspection of No.2 Outer Cooling Ring
using Guide Tubes
Figure 604 (Sheet 4 of 7)

Probe Inspection of No.2 Outer Cooling Ring using Guide Tubes
Figure 604 (Sheet 5 of 7)



DIAGRAMMATIC VIEW LOOKING FORWARD
ESTIMATE THE ZONE BOUNDARIES IN RESPECT OF THE PLUNGINGS

Probe Inspection of No.2 Outer Cooling Ring
using Guide Tubes
Figure 604 (Sheet 6 of 7)

CR 36422/00A
BS0002461/2

12.500 (APPROX)
(317,50)

OUTER BARREL

INNER BARREL

ZONE 3L

FRONT FAIRING WITH
VAPORISERS

PLUNGINGS

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

RIGHT HAND PORT

GUIDE TUBE
S3S 20081020

LEFT HAND PORT

COMBUSTION CHAMBER
OUTER CASING

LOWER PORT

CAUTION: THE SHADED AREAS ARE DIAGRAMMATIC AND SHOW ONLY THE RADIAL DISTANCE OF THE INNER SURFACE OF THE No 2 OUTER COOLING RING TO BE INSPECTED.

DIMENSION GIVEN ARE SHOWN THUS: INCHES (MILLIMETRES)

DIAGRAMMATIC VIEW LOOKING FORWARD

ESTIMATE THE ZONE BOUNDARIES IN RESPECT OF THE PLUNGINGS

Probe Inspection of No.2 Outer Cooling Ring
using Guide Tubes
Figure 604 (Sheet 7 of 7)

(2) Assemble blanking cover to right-hand inspection port.

R **CAUTION:** IT IS ESSENTIAL THAT LUBRICANT 'C'
R IS USED ON THE APPLICABLE BOLTS/NUTS
R DURING ASSEMBLY.
R (REF. SB.OL.593-72-9044-436).

(a) Apply lubricant C to bolts (Ref. 70-00-01).

(b) Locate the cover on the port, together with the spacer plate on engines to pre S.B.OL.593-72-62/ S.B.OL.593-72-8629-256 standard (Detail B), and retain in position with six bolts lightly tightened.

(c) Torque-tighten the six bolts to 100 lbf in (11,5 Nm).

(d) Wire-lock bolts together.

(3) Assemble blanking cover to bottom inspection port (Detail C).

R **CAUTION:** IT IS ESSENTIAL THAT LUBRICANT 'C'
R IS USED ON THE APPLICABLE BOLTS/NUTS
R DURING ASSEMBLY.
R (REF. SB.OL.593-72-9044-436).

(a) Apply lubricant C to bolts.

(b) Locate the cover on the engine with a gasket (S.B.OL.593-72-58) interposed, and secure with six bolts torque-tightened to 100 lbf in (11,5 Nm).

(c) Wire-lock the bolts together.

B. Complete the Installation.

(1) On completion of work, close engine bay doors (Ref. 71-00-00, Servicing).

7. Acceptance Standards for Combustion Chambers (Ref.Fig.605)

A. Fuel Vaporisers.

(1) No defects are acceptable in the vaporisers.

(2) Obvious signs of overheating or burning should be reported to the Olympus Project Office, Rolls-Royce plc., Filton, Bristol, England, BS34 7QE.

B. Combustion Chamber - Complete Assembly (Excluding Fuel Vaporisers).

(1) Chipping and/or spalling of thermal barrier coating (TBC) is acceptable. Loss of TBC may however reduce the life potential of the combustion chamber. No additional inspections are required.

(2) Acceptance standards which apply to specific sections of the combustion chamber are given in the following paragraphs.

C. Head Assembly.

(1) Corrosion damage is acceptable provided the area of corrosion does not exceed the limit shown in Figure 606 and there is no holing.

(2) Front fairing burns/blisters are not acceptable.

(3) Circumferential cracking at the front fairing/No.2 cooling ring welds is not acceptable.

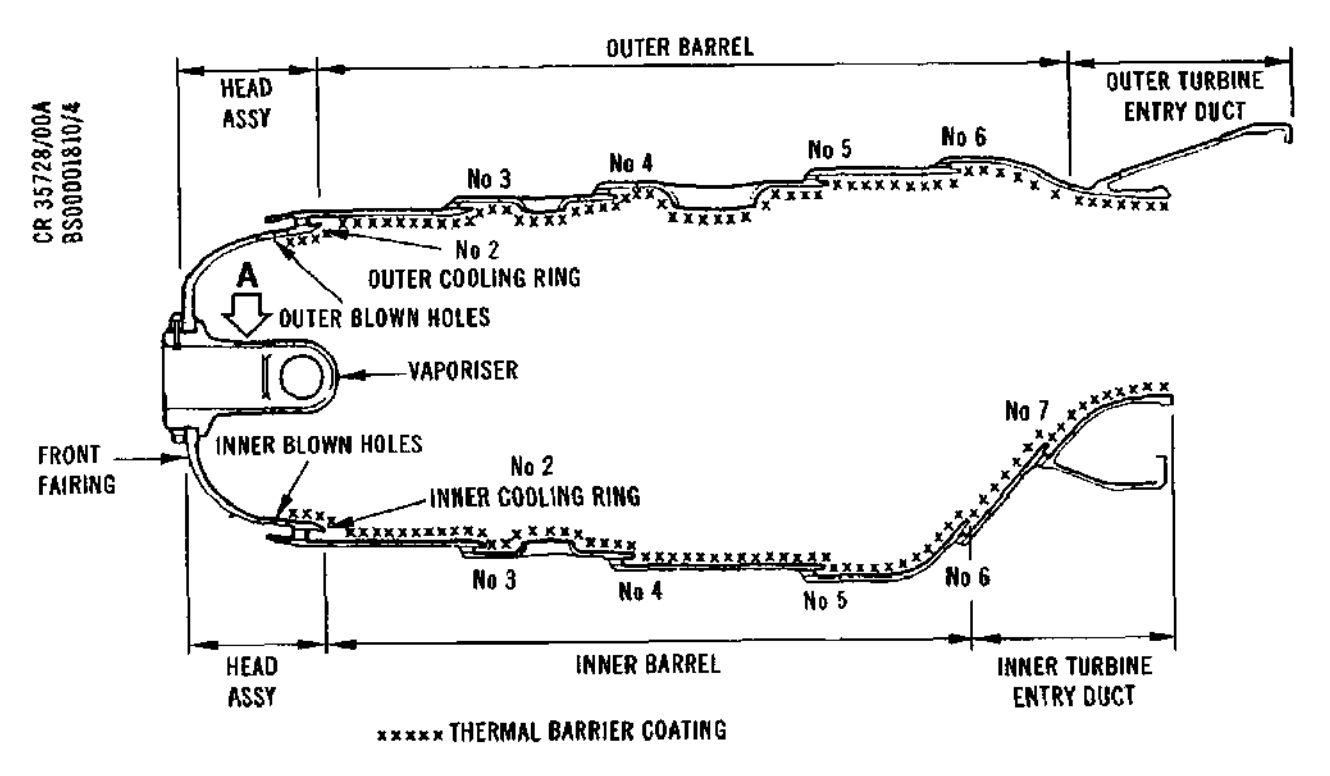
(4) Axial cracking forward of the front fairing/No.2 cooling ring welds is not acceptable.

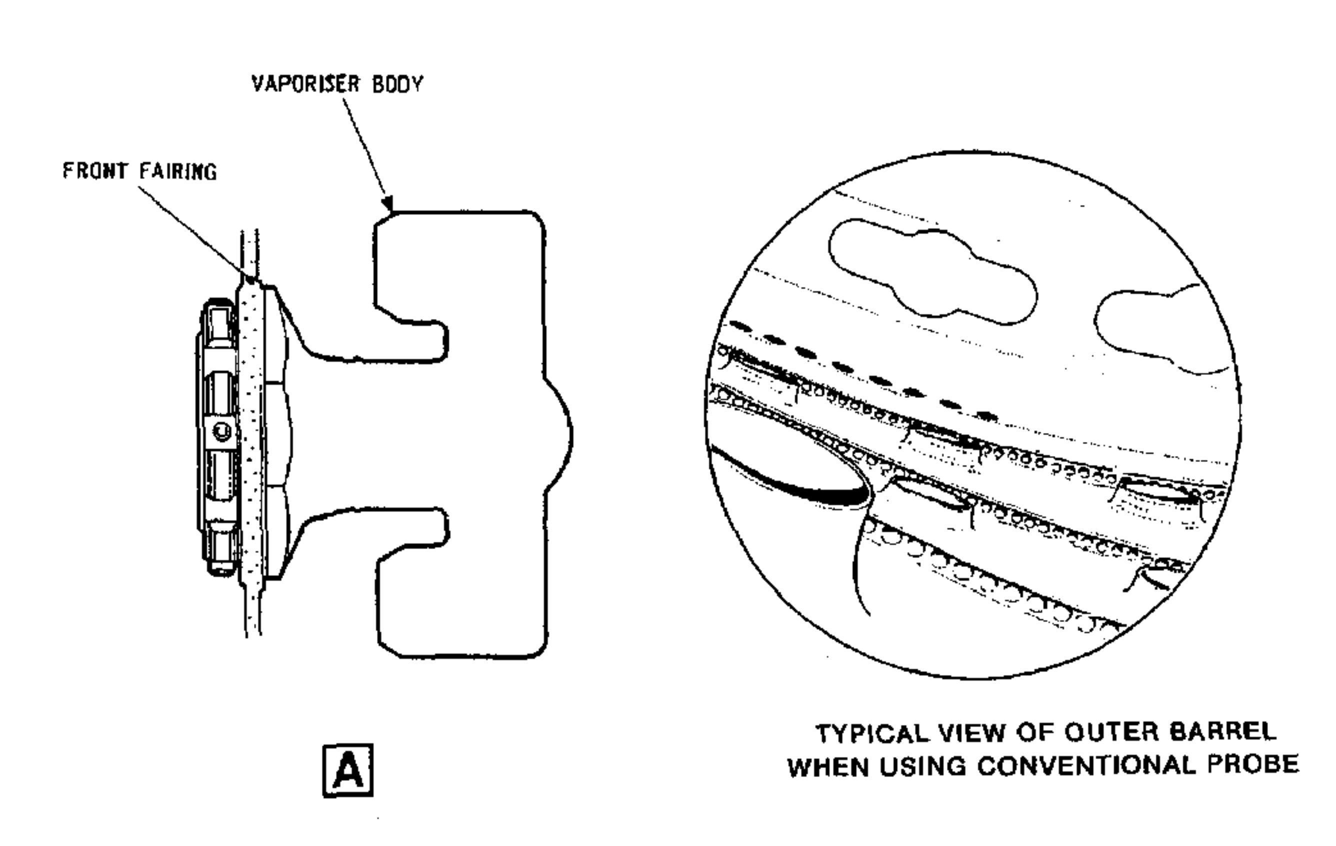
(5) Axial cracks in the No.2 cooling rings originating from the No.2 cooling ring scoops are not acceptable (Ref. Figs.607 and 608). If found, take the following action:

(a) Remove engine from airframe for further investigation

(b) Report all findings to the Olympus Project Office, Rolls-Royce plc, Filton, Bristol, England, BS34 7QE.

CR 35728/00A
BS0000181O/4

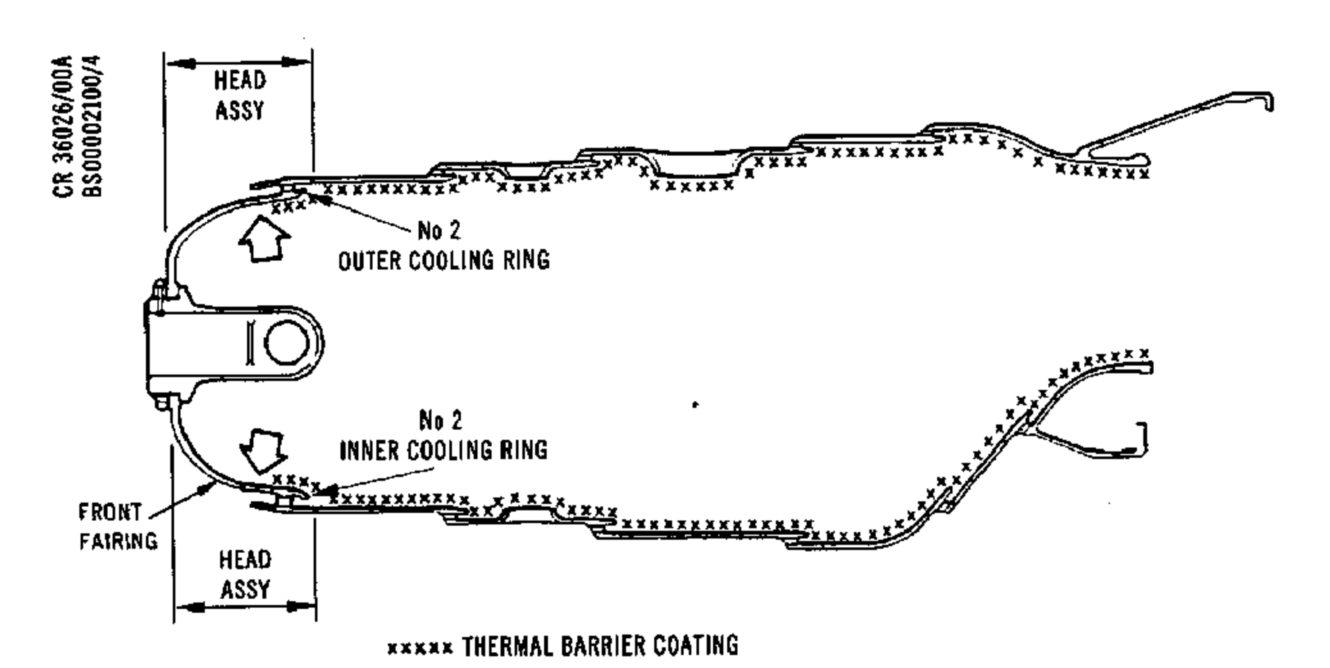


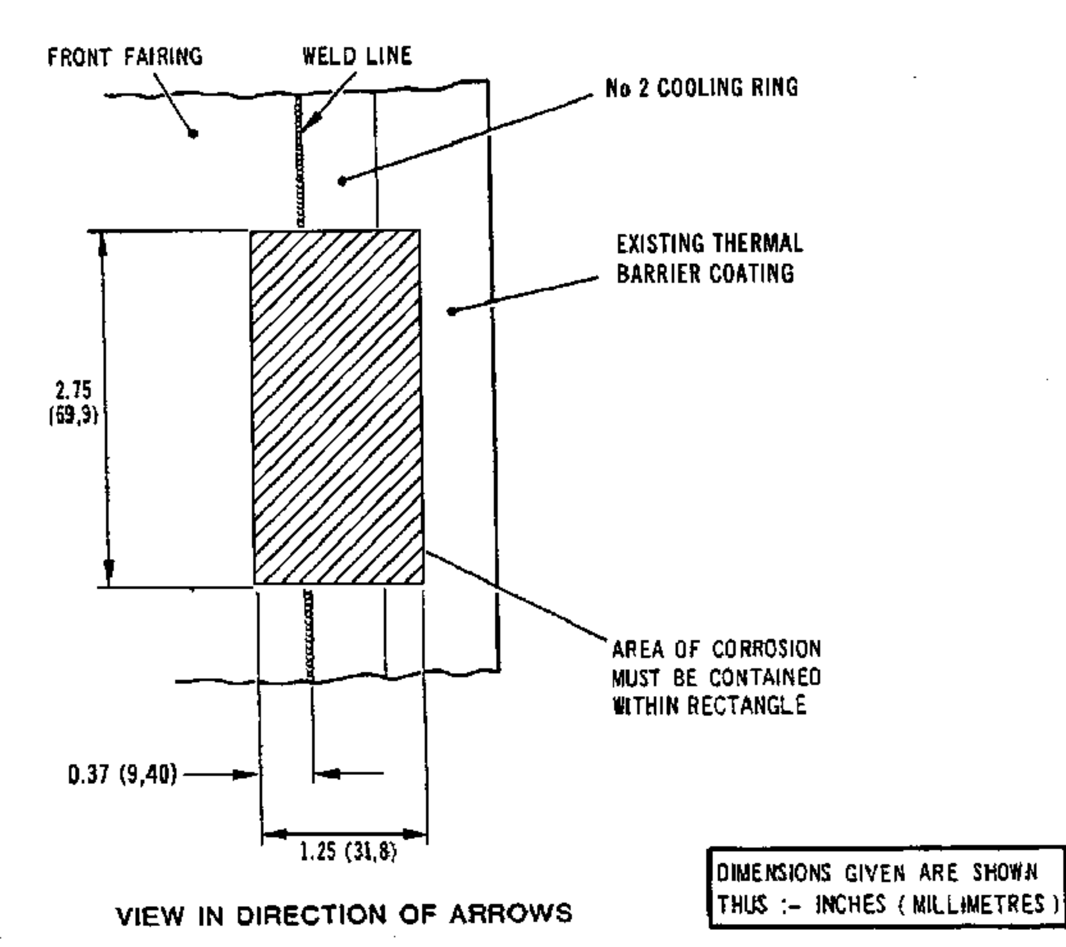


TYPICAL VIEW OF OUTER BARREL
WHEN USING CONVENTIONAL PROBE

Combustion Chamber Identification
Figure 605

CR 36026/00A
BS00002100/4

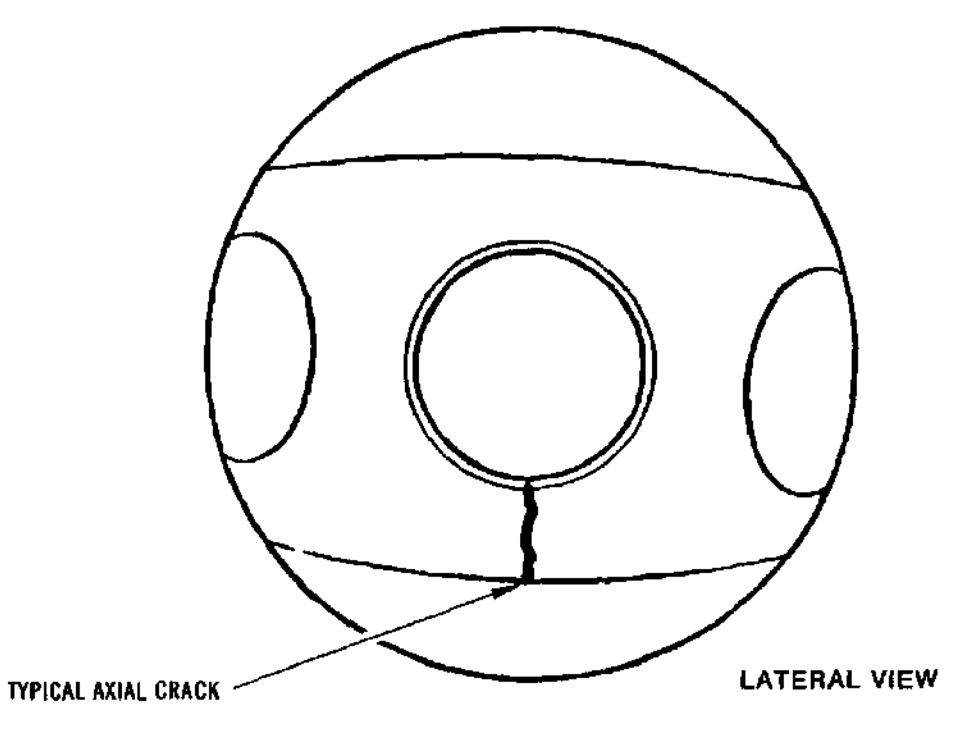


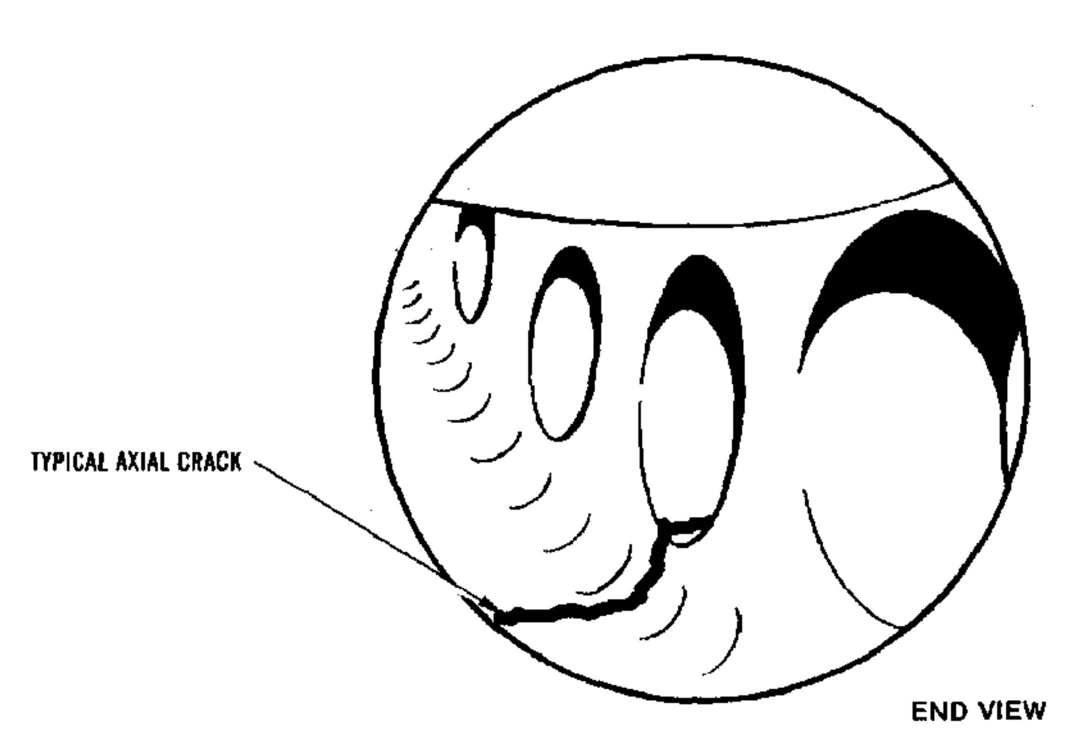


Acceptable Corrosion Damage
Figure 606



CR 36644/00A
BS00002639/3





No 2 OUTER COOLING RING CRACK INSPECTION USING GUIDE TUBES AND FLEXIBLE PROBE (REF FIG 604)

Typical Axial Cracks in the No.2 Outer Cooling Ring
Emanating from the No.2 Cooling Ring Scoop
Figure 607

(3) Assemble blanking cover to bottom inspection port (detail C).

(a) Apply lubricant A to bolts.

(b) Locate the cover on the engine with a gasket (SB OL593-72-58) interposed, and secure with six bolts torque-tightened to 100 lbf in. (11,5 N.m).

(c) Wire-lock the bolts together.

B. Install HP Compressor Diffuser Case Blanks.

(1) Assemble a flat washer to blanking plug and apply lubricant A to plug threads.

(2) Screw blanking plug into its location and torque-tighten to between 540 and 600 lbf in. (61 and 67,8 N.m). Wire-lock blanking plug.

C. Complete the Installation.

(1) On completion of work, close engine bay doors (Ref.71-00-00, Servicing).

R 7. <u>DELETED</u>

R 8. <u>Acceptance Standards for Combustion Chambers (Ref.Fig.611)</u>

A. Fuel Vaporizers.

(1) No defects are acceptable in the vaporizers.

<u>NOTE:</u> Because of carbon deposition, cracks developing from the cast body/mounting adapter weld may not be easily visible.

(2) Any evidence of overheating should be reported to the
R Olympus Project Office, Rolls-Royce plc, Bristol.

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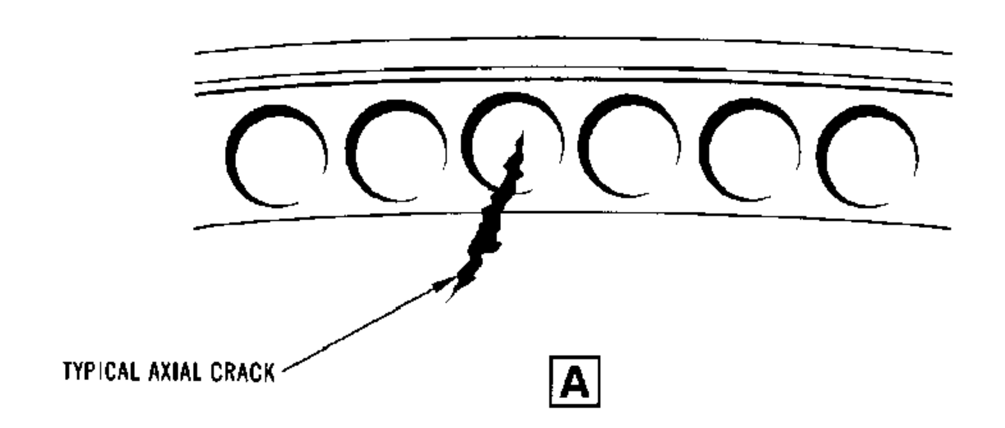
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TYPICAL AXIAL CRACK

No 2 INNER COOLING RING

A

FORWARD



No 2 INNER COOLING RING AXIAL CRACK INSPECTION
USING CONVENTIONAL SCOPE

Typical Axial Cracks in the No.2 Inner Cooling Ring
Emanating from the No.2 Cooling Ring Scoop
Figure 608

(6) Loss of material from the No.2 outer cooling ring scoop is not acceptable (Ref.Fig.609)

NOTE: Complete viewing of this location is not possible. However, any material missing from the scoop would be carried rearwards to become trapped in the annulus between the combustion chamber and CCOC or against the HE igniter and pilot nozzle. In most instances, the debris would tend to drop to the bottom of the annulus.

(7) Circumferential cracking between cooling holes in the No.2 outer cooling ring is not acceptable unless the following acceptance limits are met (Ref.Fig.610). This inspection must be carried out using Guide Tube Kit S3S.20081000.

NOTE: If the following acceptance limits are met, further inspections must be carried out at intervals not exceeding 50 hours.

(a) A maximum of 2 lands between 3 holes cracked in any one group.

(b) There must be at least 84 holes (60 degrees) between each cracked group.

(c) Subject to the above criteria there is no limit to the number of cracked groups.

NOTE: If the following acceptance limits are met, further inspections must be carried out initially at every return to main base (not exceeding 25 hour intervals) until the propagation rate of the damage is determined. When crack propagation rate is known, inform Olympus Project Office, Rolls-Royce plc, Filton, Bristol, England, BS34 7QE.

(d) A maximum of 27 lands between 28 holes (20 degrees cracked in a single group.

(e) There must be at least 84 holes (60 degrees) between each cracked group.

CR 35869/00A
BS0001946/3

ENGINE IGNITER PLUG

CHECK FOR DEBRIS IN THIS AREA

HP NOZZLE

No 2 OUTER COOLING RING SCOOP

CCOC

ANNULUS

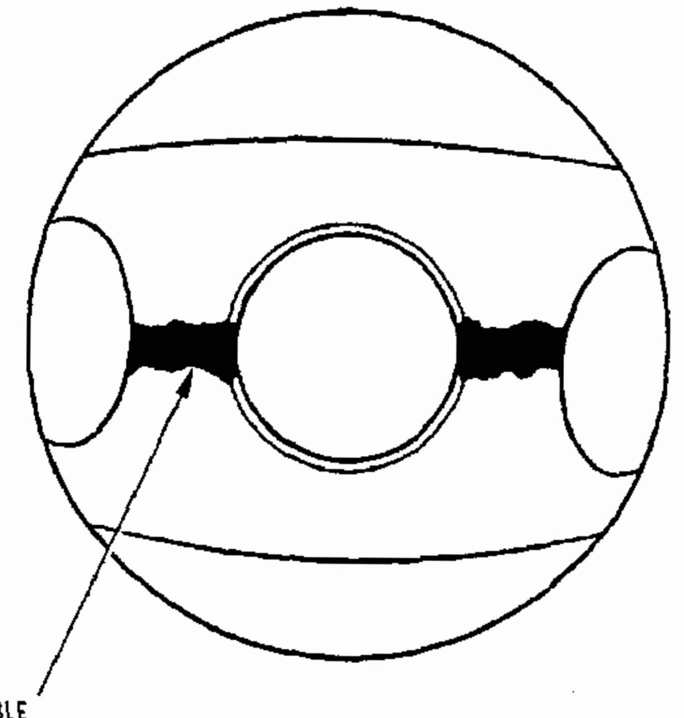
CHECK FOR DEBRIS IN THIS AREA

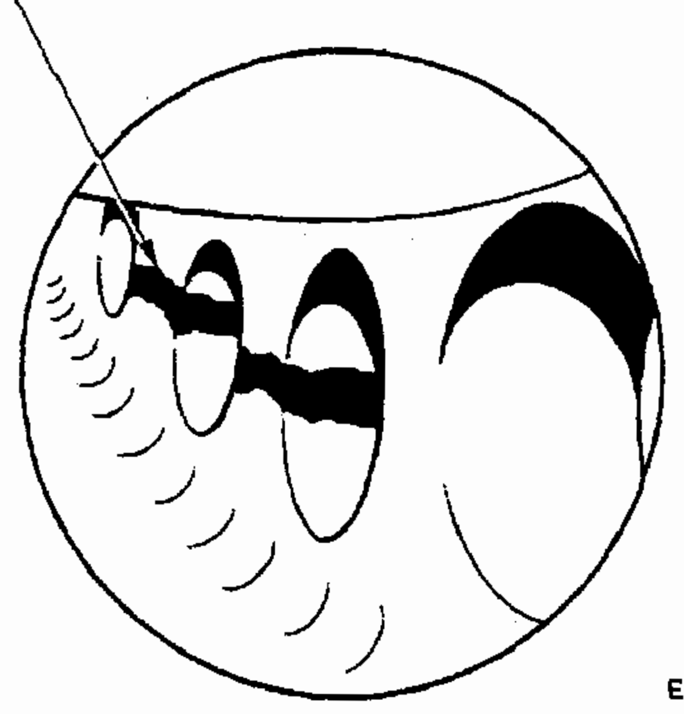
COMBUSTION CHAMBER OUTER SURFACE

INSPECTION PORT

Intrascope Examination for Debris from No.2 Outer Cooling Ring Scoop
Figure 609

CR 36425/00A
BS00002464/2





No 2 OUTER COOLING RING CRACK INSPECTION USING GUIDE TUBES AND FLEXIBLE PROBE (REF FIG 604)

Typical Circumferential Cracks Between No.2 Outer Cooling Ring Holes
Figure 610

(f) There must be no more than 42 holes (30 degrees) in total around the circumference which are joined by cracking.

(g) Subject to the above criteria there is no limit to the number of cracked groups.

NOTE: Inspection of the cooling rings within the head assembly or the inner and outer barrel assemblies may reveal circumferentially elongated cooling holes which occasionally feature in the manufacturing process of the cooling rings. There are two types of cooling ring elongation, both types are acceptable provided that the elongated surfaces are visibly machined features rather than fractures. The two types of permissible elongation are:-

Type 1 - Elongated single holes - These are single holes which have been elongated to avoid excessive land width between adjacent cooling holes.

Type 2 - Elongated double holes - These are formed where the land between two holes is removed to avoid insufficient land width
OR
Formed where the cusps between two adjacent holes are removed where the holes have broken into each other.

(8) Circumferential cracking between cooling holes in the No.2 inner cooling ring is not acceptable (Ref. Fig.611).

(9) Any number of cracks in the No.2 inner and outer cooling ring flameside lips and any number of cracks extending into, through or originating from blown holes are acceptable (Ref.Fig.612) provided that:

(a) Sections of lip are not detached.

(b) Cracks do not propagate forward of the front fairing/No.2 cooling ring welds.

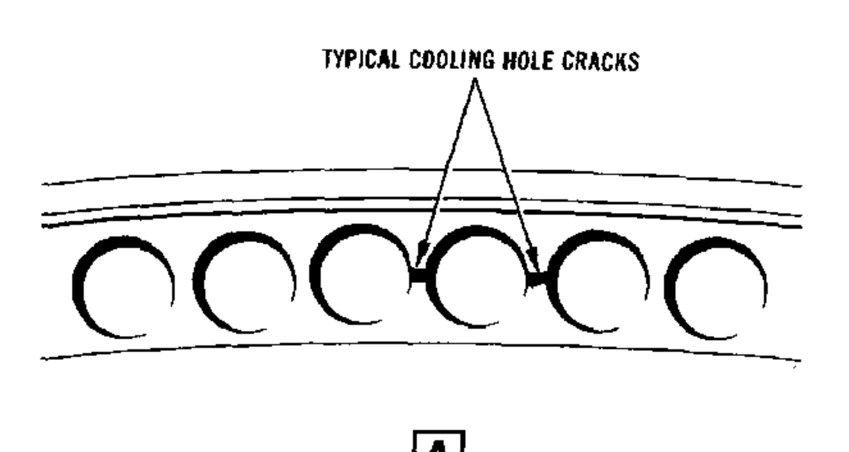
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TYPICAL COOLING HOLE CRACKS

No 2 INNER COOLING RING

A

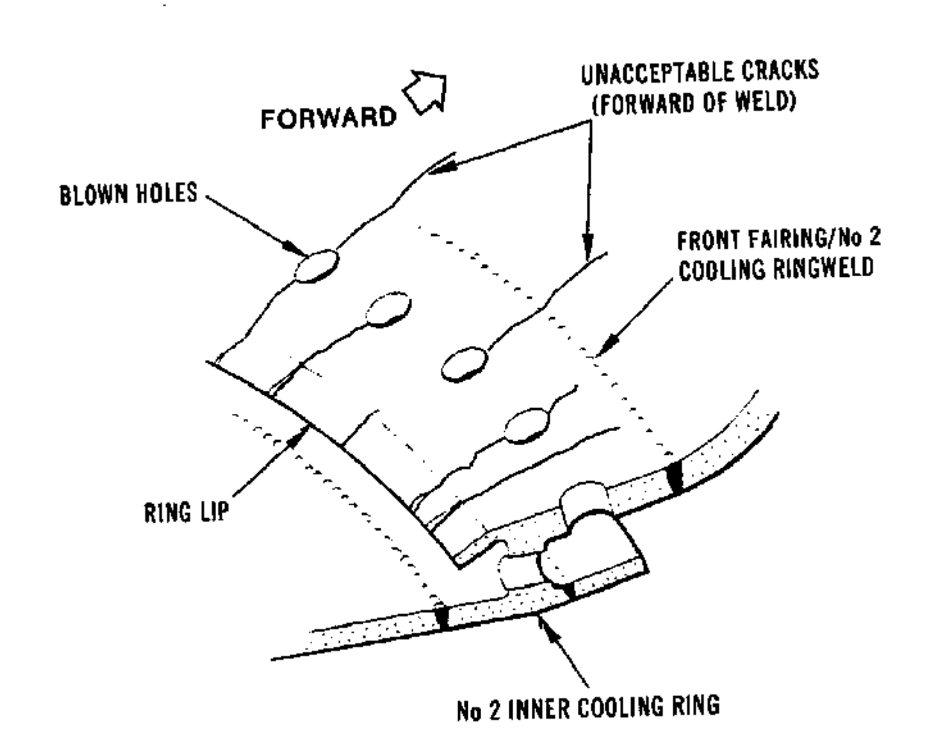
FORWARD



A

No 2 INNER COOLING RING CIRCUMFERENTIAL CRACK INSPECTION
USING CONVENTIONAL SCOPE

Typical Circumferential Cracks Between No.2 Inner
Cooling Ring Holes
Figure 611



Typical Cracks in No.2 Cooling Ring Flameside Lips
Figure 612

(c) Cracks propagating forward of the blown holes are tight (not open cracks which might indicate unacceptable cracking at the front fairing/ cooling ring weld as specified in paragraph (3)).

D. Inner and Outer Barrels.

(1) Circumferential cracks are acceptable in both inner and outer barrels separately, provided that:

NOTE: Figures 613 and 614 show the outer barrel. These figures may also be used for assessment of similar cracking in the inner barrel.

(a) In the primary zone, any cracks are confined within the boundary of a group of effusion cooling holes (Ref.Fig.613) and areas behind adjacent ports are crack free.

(b) In the intermediate and dilution zones, any cracks link no more than 2 ports in each zone (Ref.Fig.614) in any 90 deg. sector.

(2) Axial cracks in the inner and outer barrels are acceptable within the following limits.

NOTE: Figures 615, 616 and 617 show the outer barrel. These figures may also be used for assessment of similar cracking in the inner barrel.

(a) Any number of axial cracks is acceptable, provided that:

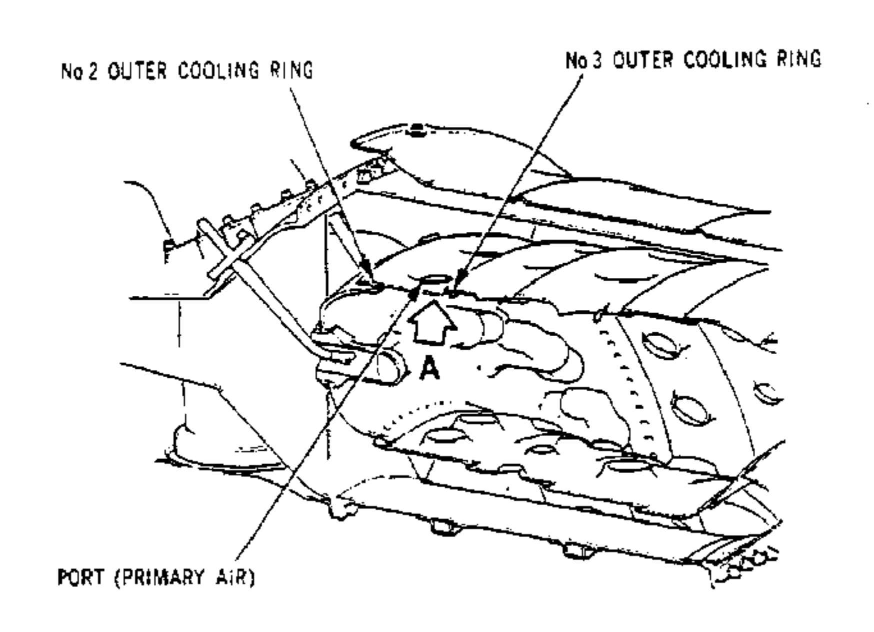
(i) The length of any single crack does not exceed the distance between any three consecutive cooling rings and,

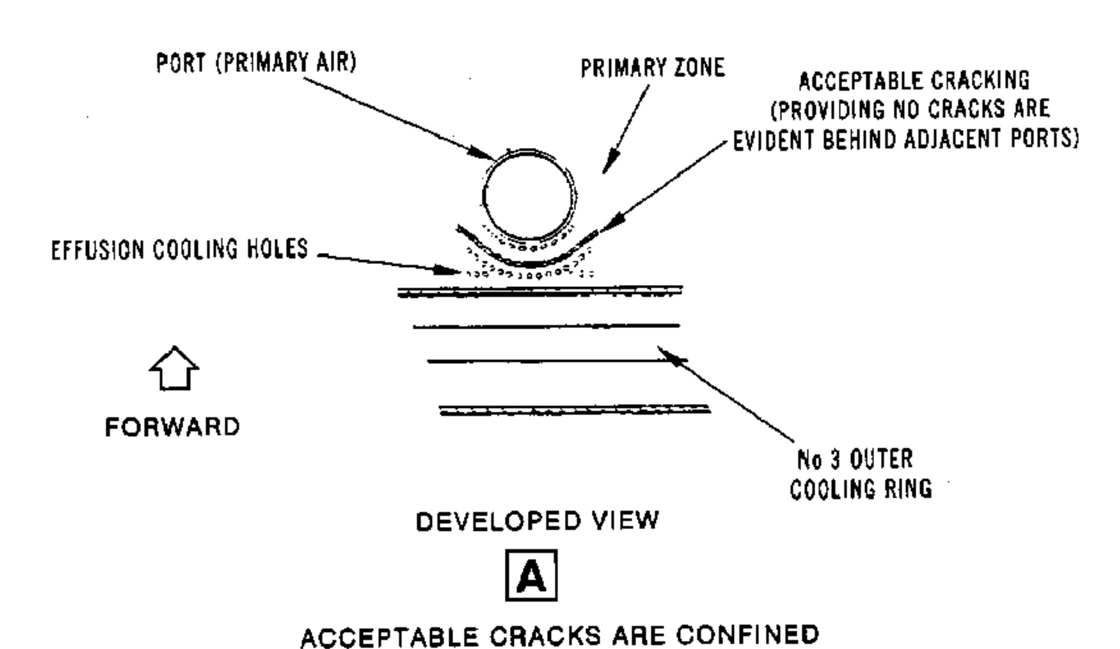
(ii) There is no danger of detachment (Ref. Fig.615) and,

(iii) There is no axial cracking in the primary zone forward of a point level with the forward edge of the primary air ports and,

(iv) The circumferential distance between any two axial cracks is not less than the distance between two plunged holes (Ref.Fig.616).

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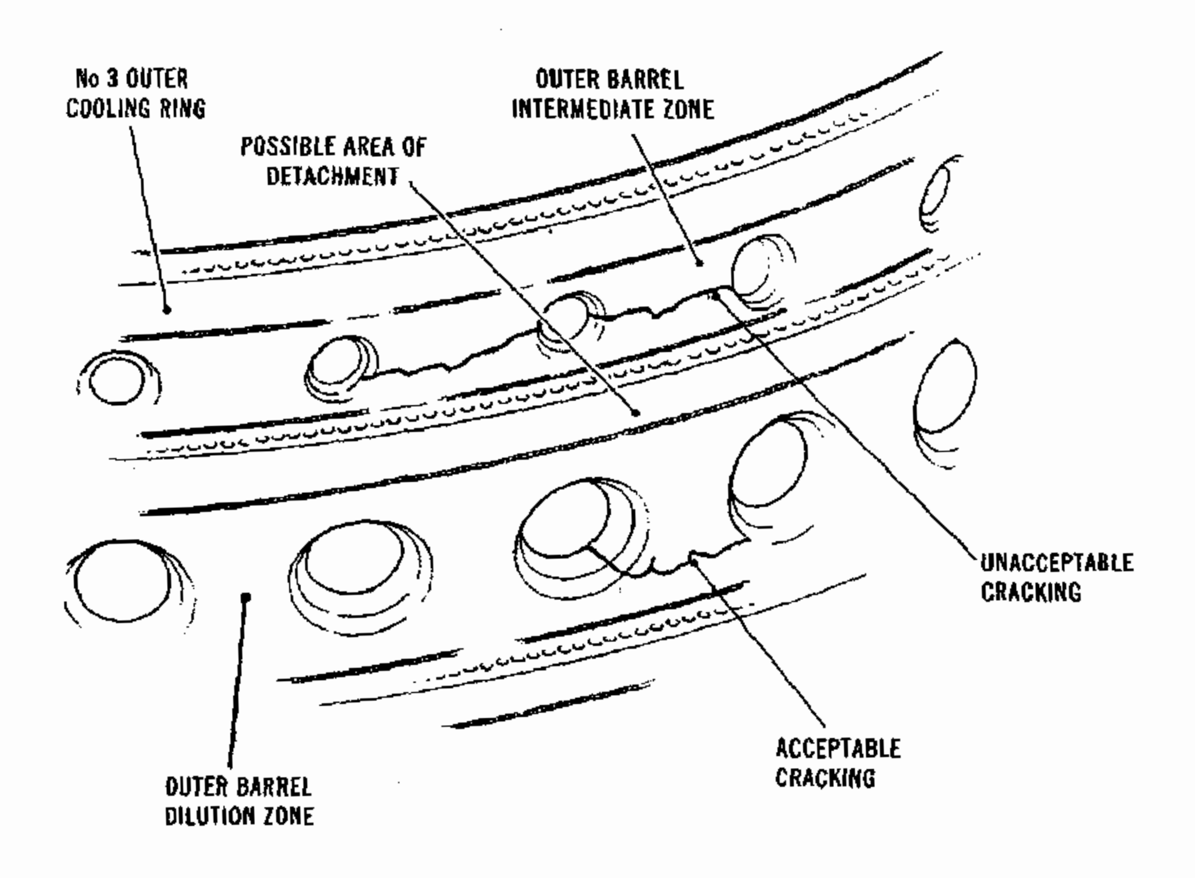




Typical Circumferential Cracks (Primary Zone)
Figure 613

BS0023709/1



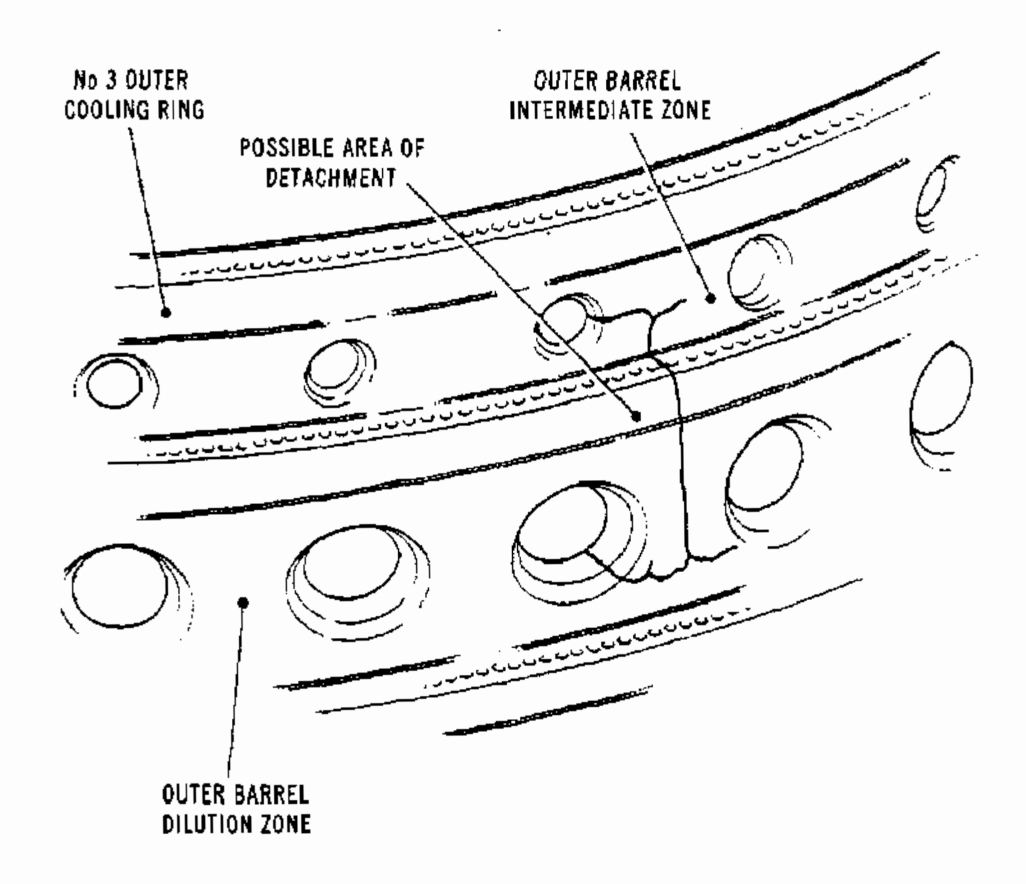


TYPICAL CIRCUMFERENTIAL CRACKING IN
THE INTERMEDIATE AND DILUTION ZONES

Typical Circumferential Cracking in the Intermediate and Dilution Zones
Figure 614

CR 36204/00A
BS00002277/3



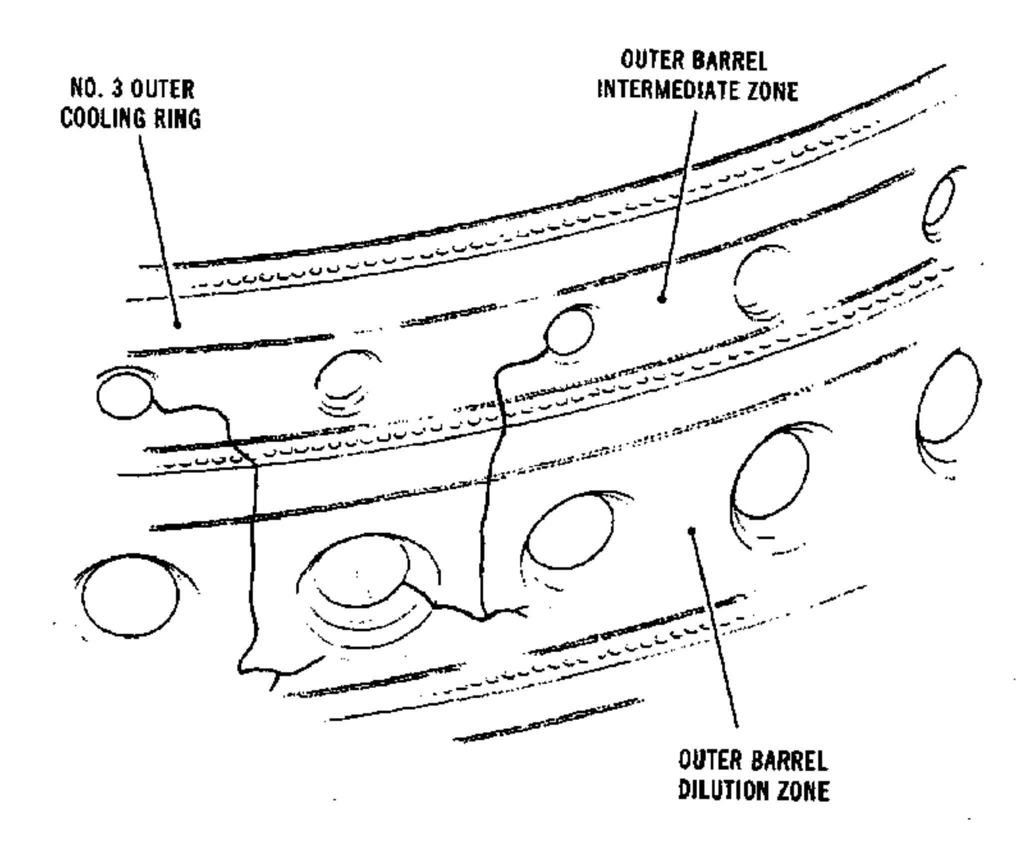


AXIAL CRACK WITH POSSIBLE AREA
OF DETACHMENT

Typical Axial Cracking
Figure 615

CR 36205/00A
BS0002278/2





CIRCUMFERENTIAL DISTANCE BETWEEN CRACKS
LESS THAN PITCH BETWEEN TWO PLUNGED HOLES

Typical Multiple Axial Cracks
Figure 616

(b) Any two axial cracks with a circumferential distance between them of less than the distance between two plunged holes are acceptable provided that:

(i) The length of any single crack does not exceed the distance between any two consecutive cooling rings and,

(ii) The cracks have not joined (Ref.Fig.617).

(3) Combinations of axial and circumferential cracks, in the permissible areas of the inner and outer barrels stated in (1) and (2), are acceptable within the following limits:

<u>NOTE:</u> Figures 618 and 619 show the outer barrel. These figures may also be used for assessment of similar cracking in the inner barrel.

(a) Any number of single cracks provided that:

(i) The length of each crack is less than the distance between any two consecutive cooling rings and the length of any circumferential crack is less than the distance between three consecutive ports and,

(ii) The distance between any two axial and circumferential crack fronts is at least the distance between three consecutive ports (Ref.Fig.618).

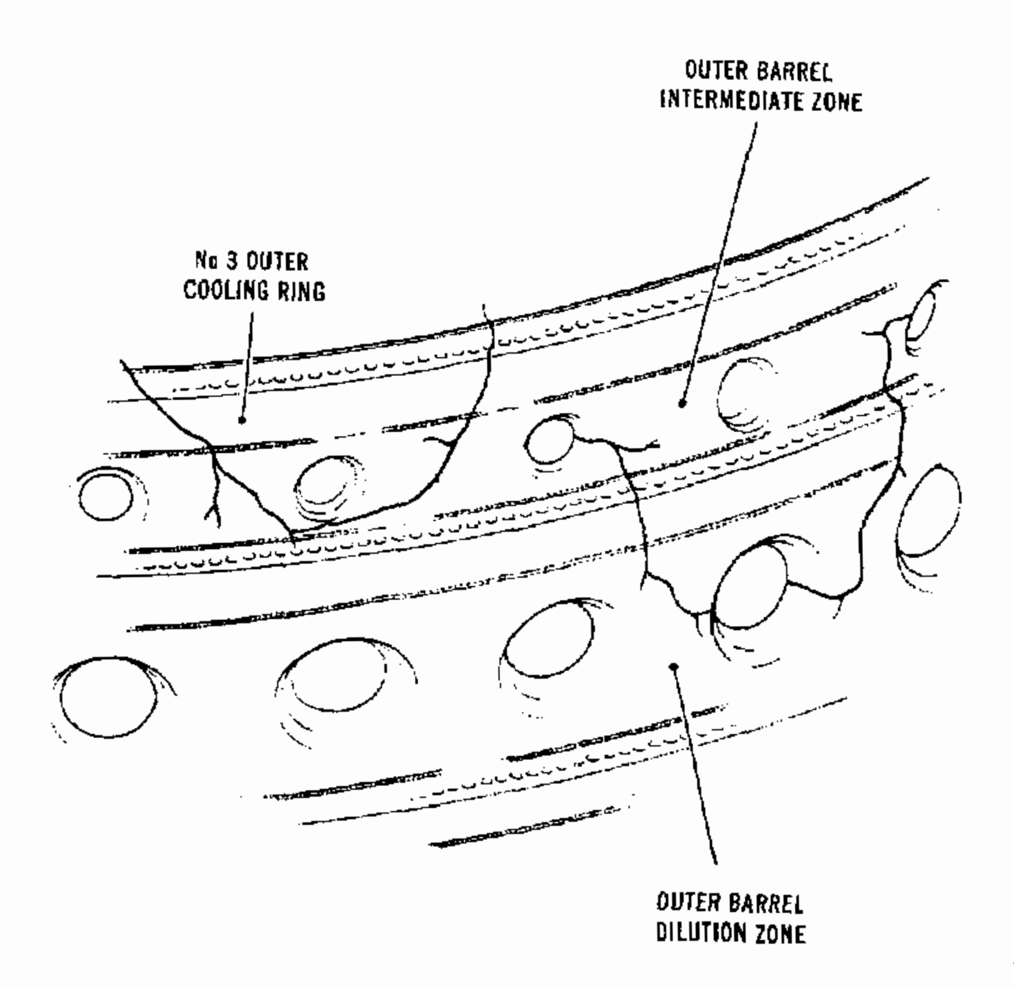
(b) Any axial crack and circumferential crack apart less than the distance between three consecutive ports provided that:

(i) The cracks do not join and,

(ii) A maximum of eight flights is not exceeded with damage monitoring checks carried out when practicable.

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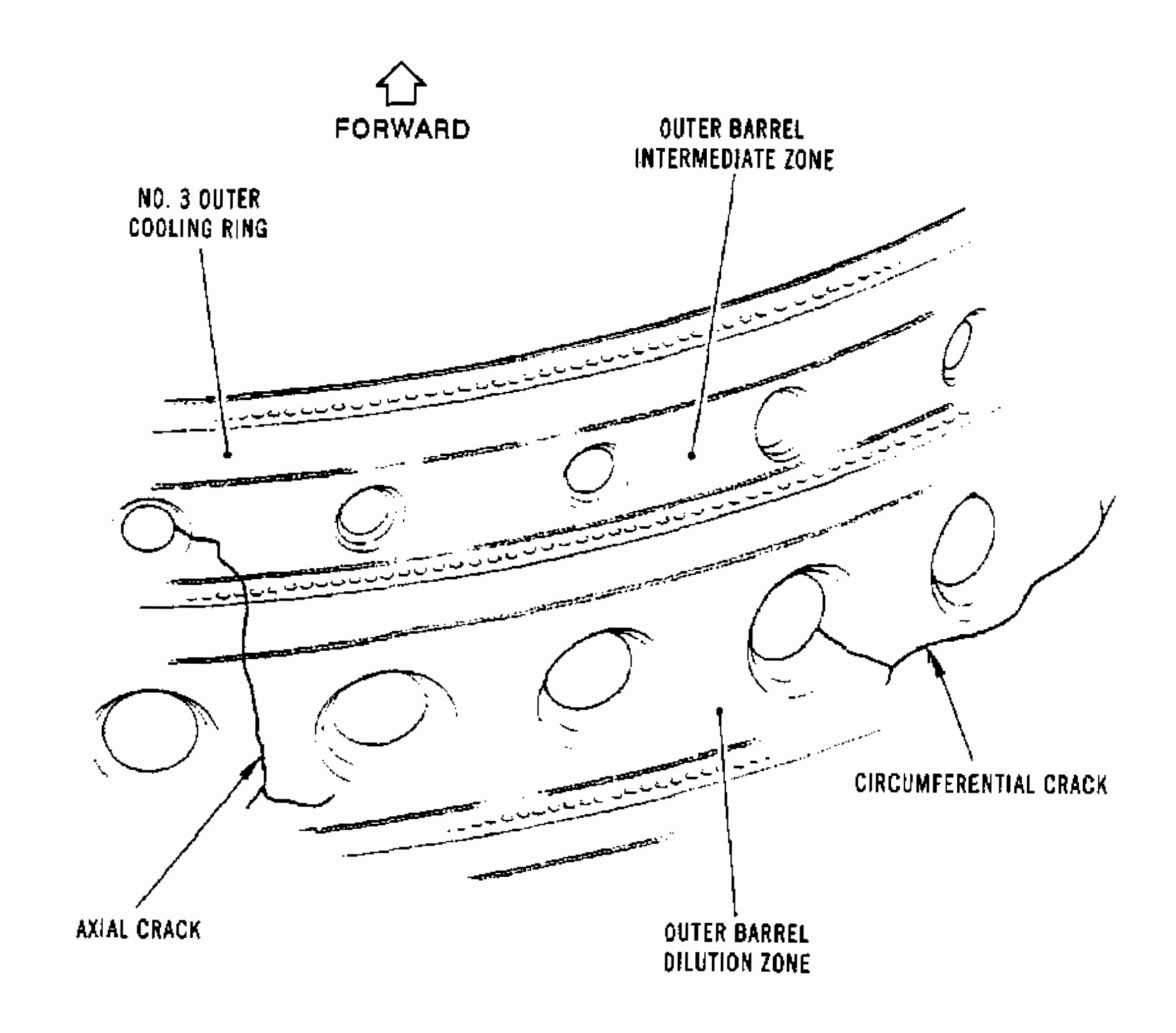




AXIAL CRACKS JOINED

Typical Multiple Axial Cracks
Figure 617

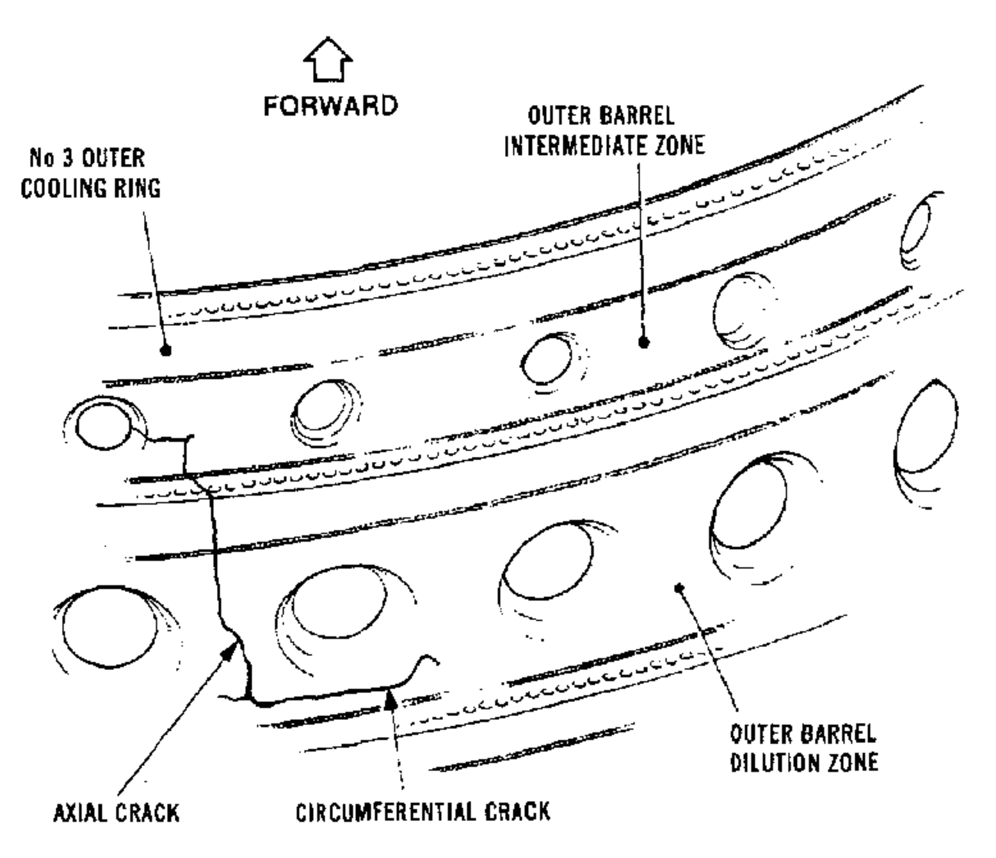
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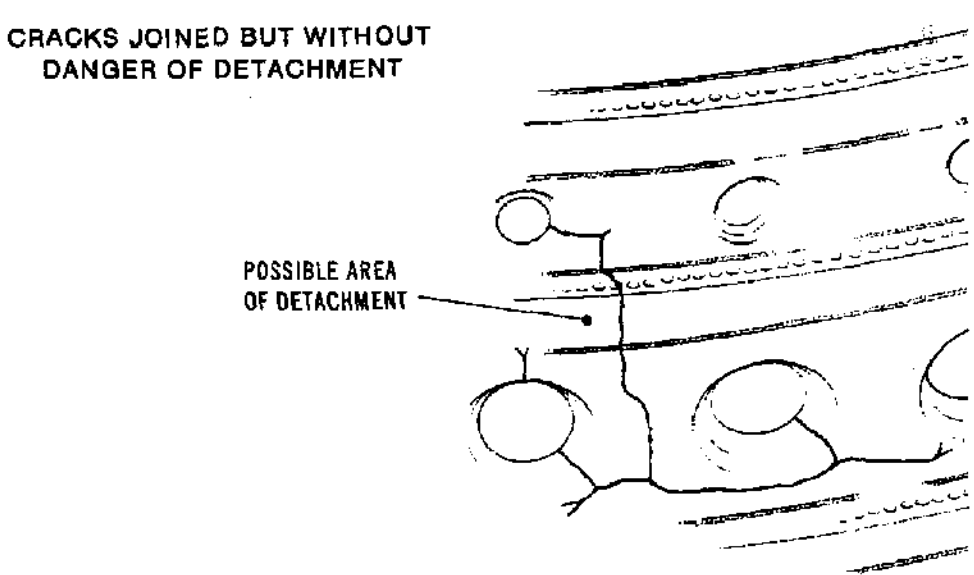
DISTANCE BETWEEN CRACKS EXCEEDS DISTANCE
BETWEEN THREE PORTS

Typical Axial and Circumferential Cracks
Figure 618

CR 36208/00A
BS00023640/1



CRACKS JOINED BUT WITHOUT
DANGER OF DETACHMENT



CRACKS PROPAGATED WITH
POSSIBLE AREA OF DETACHMENT

Typical Axial and Circumferential Cracks
Figure 619

(c) Any single axial crack and circumferential crack that join provided that:

(i) There is no danger of detachment (Ref.Fig.619) and,

(ii) A maximum of eight flights is not exceeded with damage monitoring checks carried out when practicable.

(4) Overheating or burning of the inner and outer barrels is acceptable within the following limits:

(a) One area of damage on each inner and/or outer barrel, provided that:

(i) The damage is periodically checked at intervals not greater than 50 hours of engine flight time.

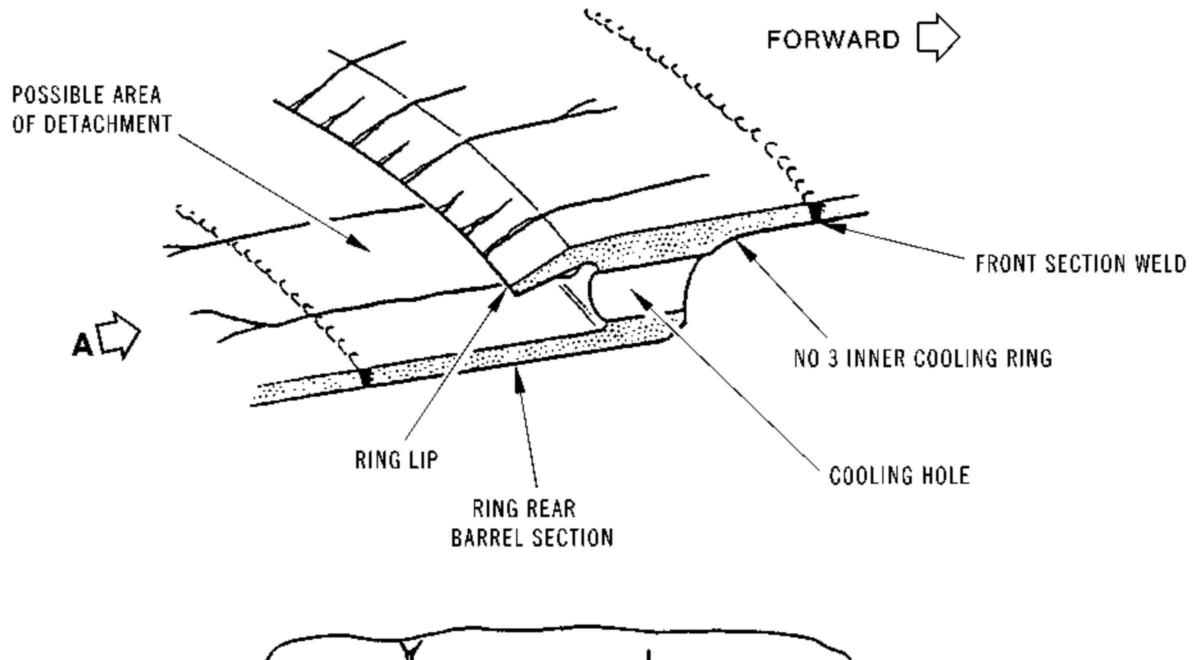
(b) One burnt area in each combustion chamber up to a maximum area contained between any two consecutive cooling rings and any two consecutive plunged holes, provided that:

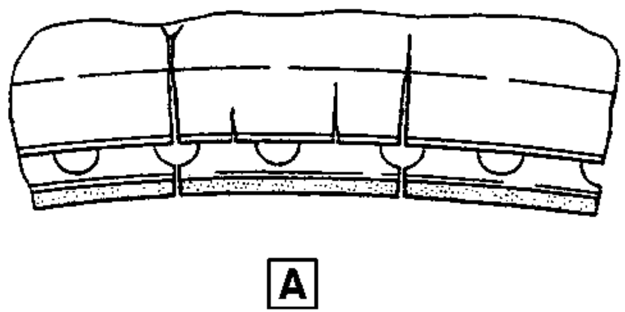
(i) There is no sign of mechanical break-up and,

(ii) The damage is periodically checked at intervals not greater than 50 hours of engine flight time.

<u>NOTE:</u> Burning of the hole plungings within the inner and outer barrel may be accepted provided the area of burning is confined to the hole plungings and that any associated cracking is within the specified limits.

BP00003573/1





A

CRACKS PROPAGATED THROUGH
COOLING HOLES INTO BARREL SECTION
(NOT ACCEPTABLE)

Typical Cracks in Cooling Ring Flameside Lips
Figure 620

(5) Cracks in the cooling ring flameside lips including No's.3,4,5,6 inner and outer and No.7 inner cooling rings but excluding No.2 cooling rings, are acceptable within the following limits:

(a) Any number of cracks in any cooling ring flame-side lip, provided that:

R (i) They do not extend into the front section
R weld (Ref. Fig.620).

R (ii) They do not propagate through the cooling
R holes into the rear ring barrel section (Ref. Fig.620).

NOTE: Cracks which propagate through
R the cooling holes into the rear
R ring barrel section are classed as axial cracks, in which case refer to preceding sections.

E. Inner and Outer Turbine Entry Duct Regions.

(1) Circumferential cracks in the inner and outer turbine entry duct regions are acceptable within the following limits.

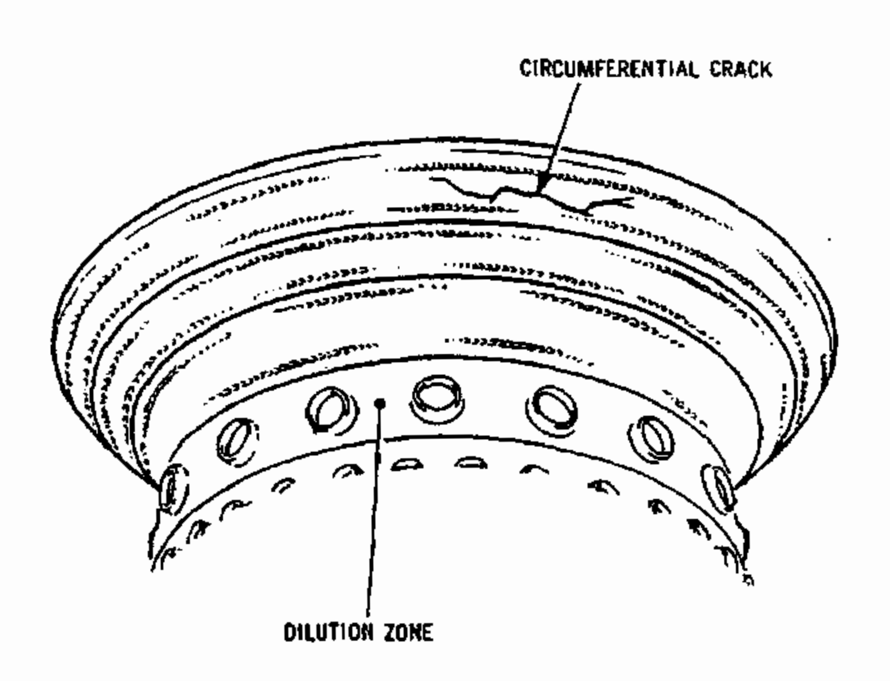
(a) A single circumferential crack is acceptable provided that:

(i) Its length is not greater than the distance between two ports in the dilution zone (Ref.Fig.621).

(b) Any number of circumferential cracks is acceptable to both the inner and outer turbine entry duct regions separately, within the limitation of paragraph (a), provided that:

(i) When the lengths of all the cracks are added together, their combined length does not exceed the distance between three consecutive ports in the dilution zone (Ref.Fig.622).

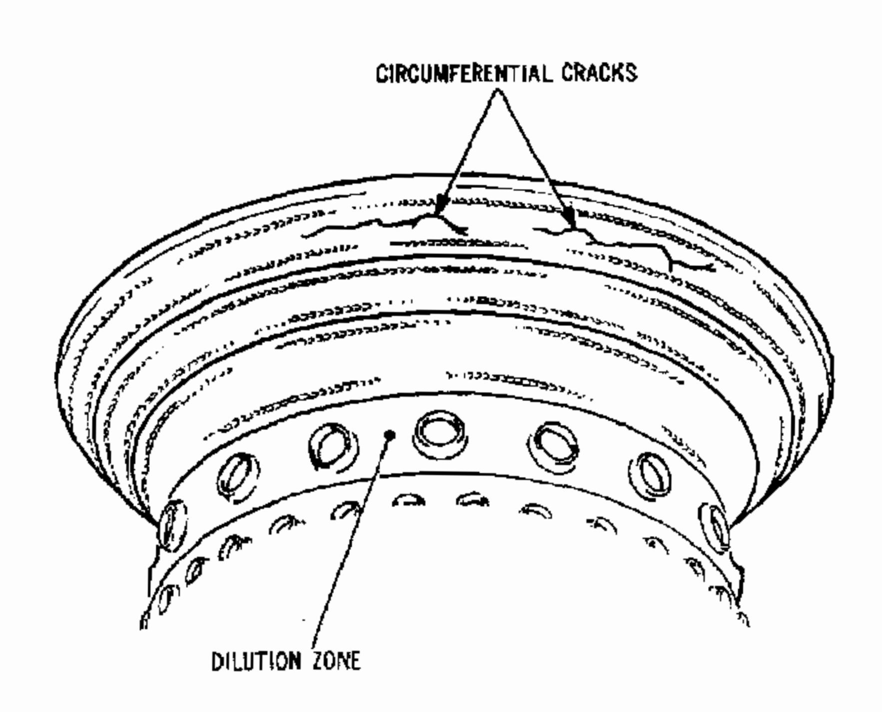
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LENGTH OF CRACK EXCEEDS DISTANCE BETWEEN TWO PORTS IN DILUTION ZONE

Typical Cracks in Turbine Entry Duct
Figure 621

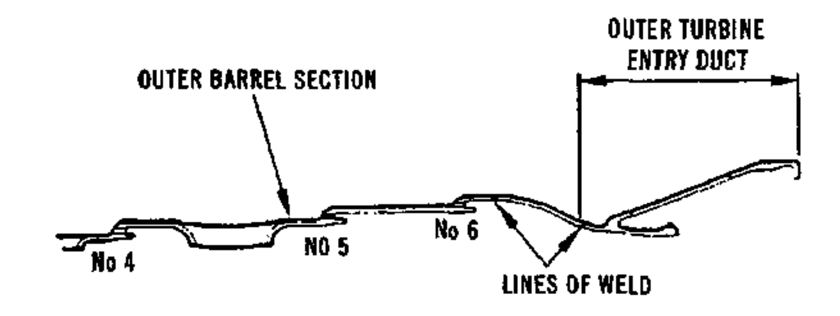
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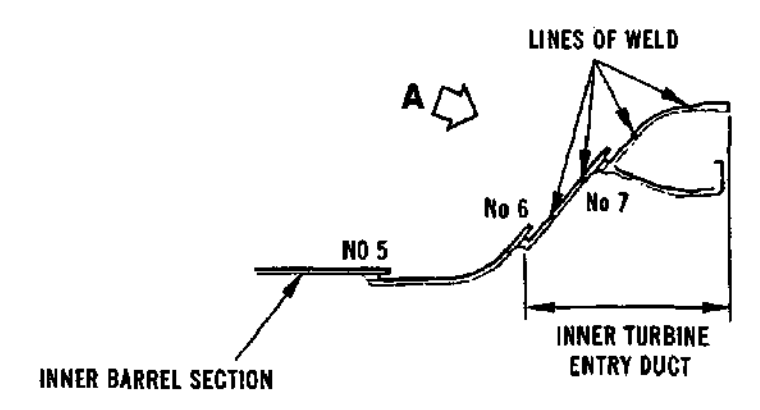


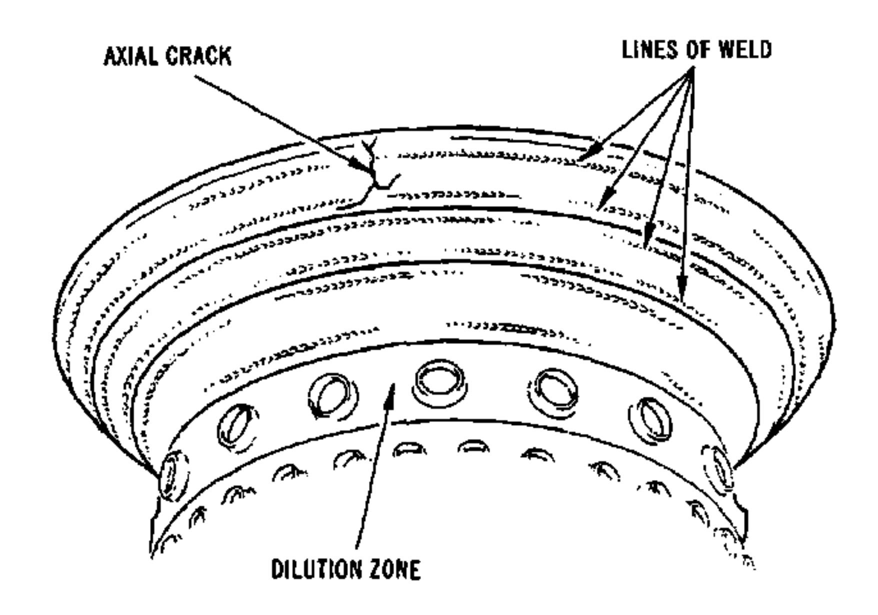
TOTAL LENGTH OF CRACKS EXCEEDS DISTANCE
BETWEEN THREE PORTS IN DILUTION ZONE

Typical Multiple Crack in Turbine Entry Duct
Figure 622

CR 36214/00A
BS00023641/2









LENGTH OF CRACK EXCEEDS DISTANCE
BETWEEN LINES OF WELD

Typical Crack in Turbine Entry Duct
Figure 623

(2) Axial cracks in the inner and outer turbine entry duct regions are acceptable within the following limits.

(a) A single axial crack is acceptable provided that:

(i) Its length is not greater than the distance between any two lines of weld (Ref.Fig.623)

(b) Any number of axial cracks is acceptable provided that:

(i) The length of any crack does not exceed the limitation specified in paragraph (a) and,

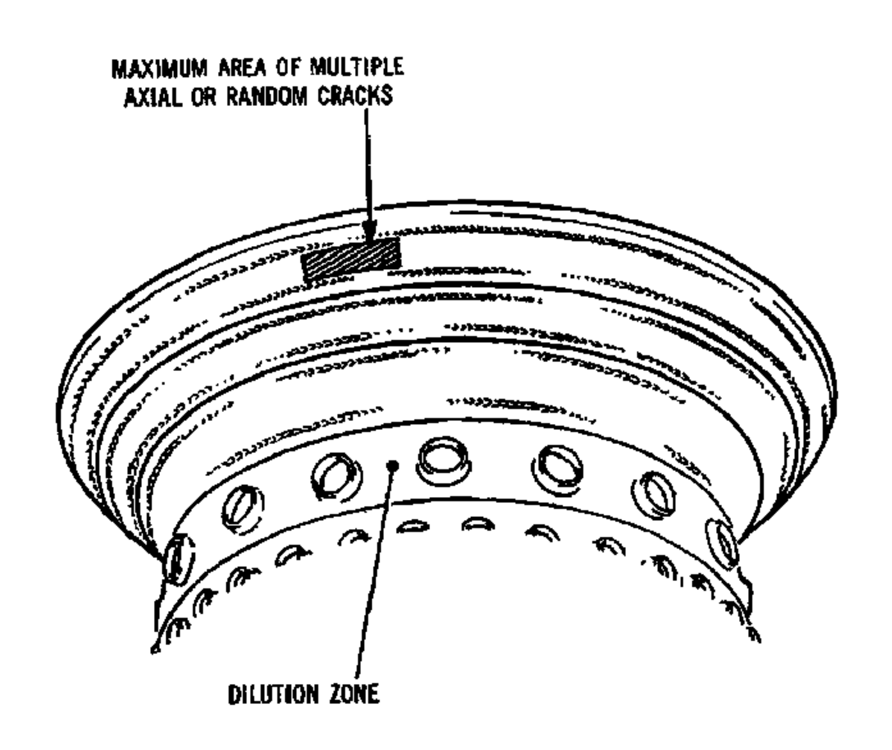
(ii) The circumferential distance between any two axial cracks is not less than 0.5 in. (12,7 mm) and,

(iii) They do not join and,

(iv) If an area of multiple axial cracks occur, subject to the limitations set out in (i), (ii) and (iii), then they must be contained in an area that covers a maximum circumferential length equivalent to the distance between two ports in the dilution zone (Ref.Fig.624) and,

(v) Any axial cracking, either single or multiple, and subject to the limitations set out in (i), (ii), (iii) and (iv), must not have propagated across the No.6 cooling ring adjacent to the outer turbine entry duct or the No.6 or No.7 cooling rings adjacent to the inner turbine entry duct, whichever is appropriate.

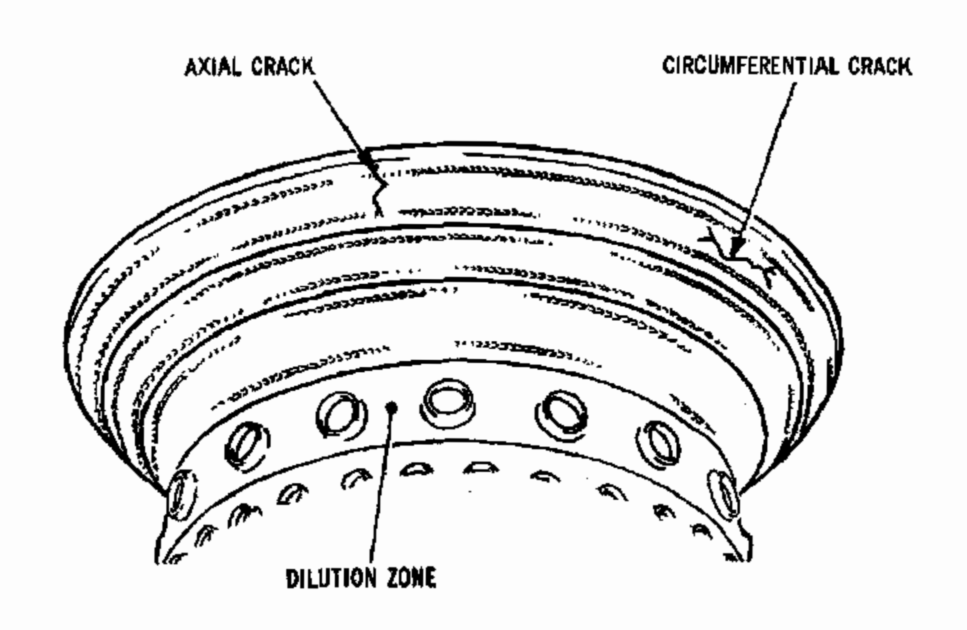
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CIRCUMFERENTIAL LENGTH OF CRACKED AREA
LESS THAN DISTANCE BETWEEN TWO PORTS
IN DILUTION ZONE

Maximum Acceptable Area of Multiple Cracks
Figure 624

CR 36216/00A
BS00002286/3



DISTANCE BETWEEN CRACKS EXCEEDS DISTANCE
BETWEEN THREE PORTS IN DILUTION ZONE

Typical Multiple Cracks in Turbine Entry Duct
Figure 625

(3) Combinations of axial and circumferential cracks in the permissible areas of the inner and outer turbine entry duct regions stated in (1) and (2) are acceptable within the following limits:

(a) Any number of single cracks provided that:

(i) The length of any axial crack is less than the distance between any two lines of weld (Ref.Fig.623) and the length of any circumferential crack is less that the distance between two ports in the dilution zone and,

(ii) The distance between any axial and circumferential crack front is at least the distance between three consecutive ports in the dilution zone (Ref.Fig.625).

(b) Any axial and circumferential cracks apart less than the distance between three consecutive ports in the dilution zone provided that:

(i) The cracks do not join and,

(ii) A maximum of eight flights is not exceeded with damage monitoring checks carried out when practicable.

(c) Any single axial and circumferential crack that join provided that:

(i) There is no danger of detachment (Ref.Fig.626) and,

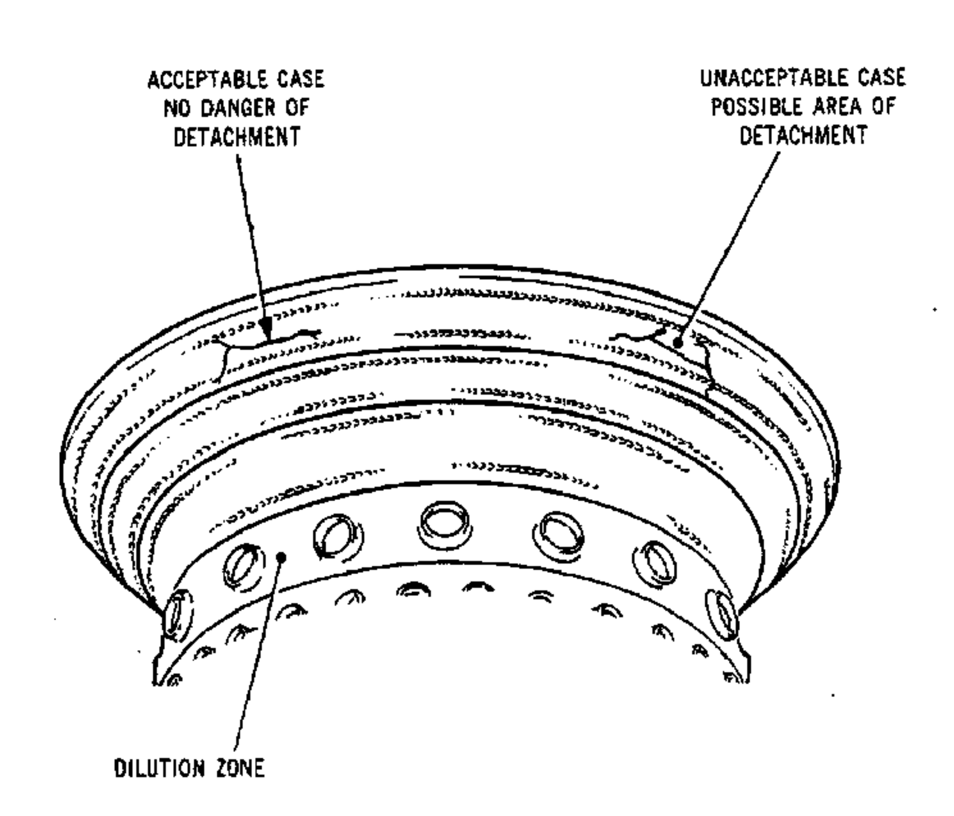
(ii) A maximum of eight flights is not exceeded with damage monitoring checks carried out when practicable.

(4) Multiple random cracks on either the inner or the outer turbine entry duct regions are acceptable within the following limits.

(a) Any single area of cracks, provided that:

(i) The damage area does not exceed the area contained between two ports in the dilution zone and any two lines of weld in the turbine entry ducts (Ref.Fig.624).

CR 36217/00A
BS0002687 3/1



AXIAL AND CIRCUMFERENTIAL CRACKS JOINED

Typical Multiple Cracks in Turbine Entry Duct
Figure 626

(b) Any single area of cracks which cover an area greater than that described in (a), provided that:

(i) A maximum of eight flights is not exceeded with damage monitoring checks carried out when practicable.

(5) Overheating or burning of the inner and outer turbine entry duct regions is acceptable within the following limits.

(a) One area of damage on each inner and/or outer turbine entry duct region, provided that:

(i) There is no sign of mechanical break-up and,

(ii) The damage is periodically checked at intervals not greater than 50 hours of engine flight time.

8. <u>Damage Monitoring Checks</u>

A. If damage to the combustion chamber sub-sections is found, within the acceptable limits stated in pararagph 7. the affected area must be inspected at the intervals specified, or at the normal interval for combustion chamber inspections whichever is the lower. This inspection must also cover the possibility of secondary damage to other areas of the combustion chamber and/or turbine assembly as follows. When secondary damage is found, it must be compared with the acceptable limits stated in paragraph 7. or Chapter 72-51-00 Inspection/ Check, as applicable.

(1) Combustion chamber damage monitoring checks.

(a) If damage has resulted in loss of material from the combustion chamber, carry out the HP turbine Inspection/Check. Comply with procedures stated, if damage is found in the HP turbine assembly (Ref. 72-51-00, Inspection/Check).

(b) Carry out visual and tactile checks of the exhaust diffuser vanes and LP turbine rotors and stators when a damaged combustion chamber with loss of material is found.

9. Intrascope Inspection

A. The following British Airways procedure and equipment is given to enable an intrascope inspection to be made of internal engine components.

B. Equipment and Materials.

(1) Intrascope Kit BAOD code HWAK 1043 with carrying case containing:

(a) Fibrelight guide cable BAOD code HZAD 1753.

(b) Lateral view Endoprobe with focusing 8 mm dia. x 19 in. long BAOD code HZAE 1279.

(c) Right angle eyepiece for use with lateral view Endoprobe BAOD code HZAM 0409.

(d) Forward view Endoprobe with fixed focus 8 mm dia. x 13 inches long.

(e) Spare bulb for the light source box BAOD code LELP 1752.

(2) Light source box (not in carrying case) BAOD code GEEB 0308 for use with the two endoprobes.

(3) Extractor pt. no. PE 17283, BAOD code HMKE 1049 (used to remove certain intrascope ports).

(4) Extension lead BAOD code GWAC 1292 (used to take a power supply from a/c vacuum cleaner sockets).

(5) Probe "Hot Light" quartz iodine 42 inches long BAOD code HZAP 2075.

C. Inspection.

(1) Intrascope inspection of internal engine components.

(a) Use of equipment.

(1)	Combustion Chamber - via CCOC outer case.	"Hot Lights" Quartz Iodine probe.

NOTE 1: Use of either the forward view endoprobe or the lateral view endoprobe solely depends on which probe the operator finds most convenient to use for the various inspections.

NOTE 2: The lateral view endoprobe with focusing can be used in conjunction with the right angle eyepiece if so desired.

D. Power Supplies.

(1) The light source box code GEEB 0308 can be operated on either 240 V AC or 110 V AC. The voltage selector is inside the box. To remove the cover remove the knurled screw on the top of the box and unscrew the two forward screws on the side of the box.

(2) Extension lead code GWAC 1292 can be plugged into the Hoover sockets located near the L/H centre toilet at floor level. This is 110 V AC. Feed the cable out through the forward passenger door to the ground.

TURBINE SECTION - DESCRIPTION AND OPERATION

1. Description

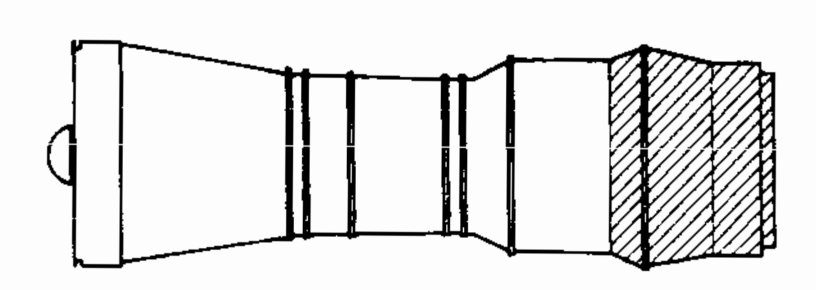
The turbine section of the engine is located rearwards from the combustion section and consists of HP and LP turbine assemblies and a turbine exhaust diffuser assembly described in detail in 72-51-00, 72-52-00 and 72-53-00 respectively. The two axial flow turbine assemblies are positioned in tandem as shown in the illustration (Ref. Fig. 001), with the HP turbine assembly at the front. The turbine exhaust diffuser assembly, located rearward of the LP turbine assembly, supports the spherical flange adapter and jet pipe.

2. Operation of Turbine Section

The axial gas flow from the combustion section enters the HP turbine nozzles where it is accelerated and directed to impinge on the HP turbine rotor blades at an effective angle. The turbine absorbs a proportion of the gas energy to drive the HP compressor rotor and associated accessories. The gas flow then passes axially into the LP turbine nozzles where it is again accelerated and directed on to the LP turbine rotor blades to drive the LP turbine rotor and compressor rotor. The gas flow leaves the turbine and flows axially via the exhaust diffuser assembly to the exhaust system.

Cooling air flows are directed to the turbine section as described in 72-02-00 and combine with the gas flow.

CR 30435/00A



COMBUSTION CHAMBER OUTER CASE

H P TURBINE NOZZLE VANE

L P TURBINE NOZZLE VANE

TURBINE EXHAUST DIFFUSER ASSEMBLY

REHEAT INJECTION SYSTEM (73 10 00)

CMR 72 50 00 0 AAM0

H P TURBINE BEARING HOUSING

H P TURBINE ROTOR

L P TURBINE ROTOR

L P SHAFT SIGNAL SYSTEM (76-20-00)

JET PIPE THERMOCOUPLE ASSEMBLY (77-20-00)

Turbine and Exhaust Diffuser
Figure 001

TURBINE SECTION - INSPECTION/CHECK

1. It is also a MANDATORY requirement to carry out the HP turbine Nozzle Guide Vane Pin and Bolt Inspection paragraph 2 below, in the event of certain system warning or malfunctions. The details are as follows:

   A. Reason for Inspection.

      As inspection MUST be carried out whenever there has been a warning OR a malfunction on any of the following systems unless it can be PROVEN that the cause was other than a hot gas leak from the nozzle pin/bolt area.

      (1) Nacelle/wing overheat detection system.

      (2) Torching flame detection system.

      (3) Fire detection system.

   B. Read the following information regarding the use of bore-scope equipment. This outlines how these may affect safety and their classification relative to our Procedures. The precautions listed <u>must</u> be complied with.

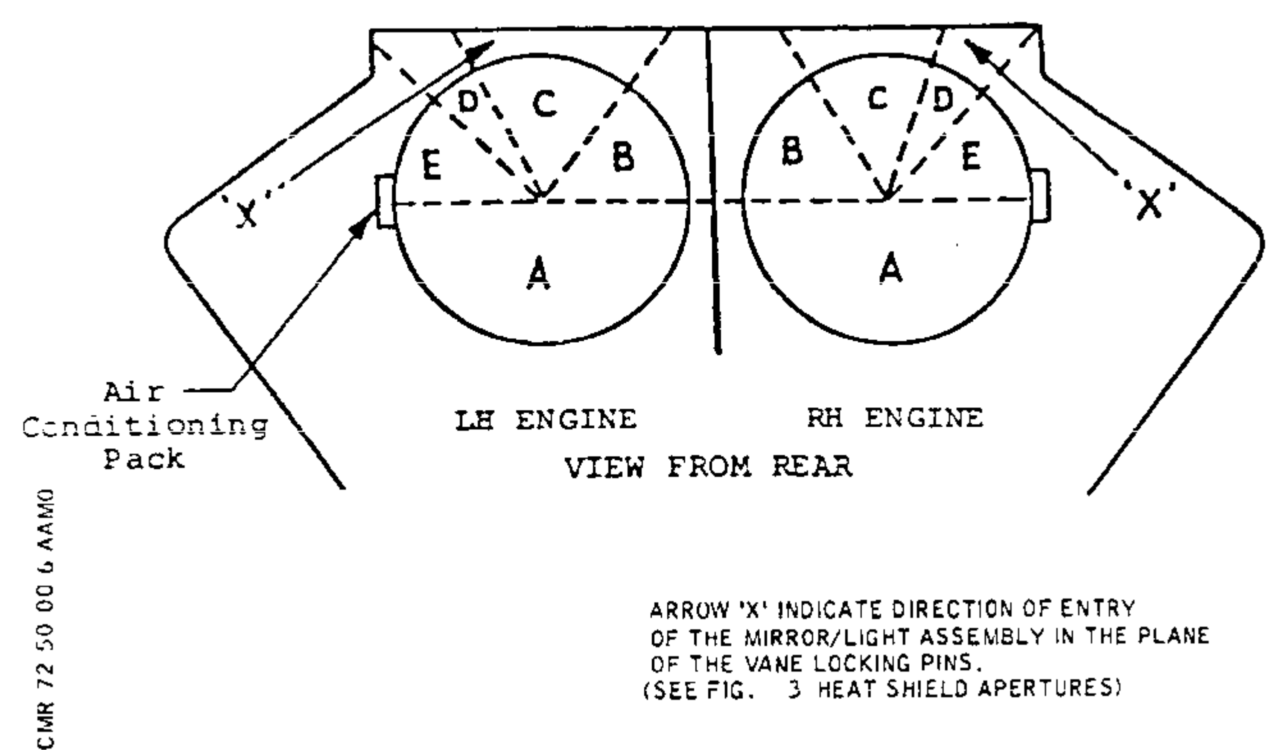
      (1) <u>Background and Description</u>

         Borescope inspections of internal engine components are frequently carried out. These inspections, when conducted with equipment utilising a light source box, now require additional precautions to be taken to eliminate risk of hazard when used in an environment potentially containing combustible gases.

         Engines installed or near an aircraft, inside or outside a hangar, fall within the compass of this environment. Uninstalled engines in workshops may also be in a hazardous environment.

         These environments are termed "Zone 2" areas but dedicated Zone 2 certification for equipment is not granted by the Regulatory Authority and it is deemed "UNCERTIFIED EQUIPMENT".

         A borescope kit comprises of several pieces of equip-ment but it is <u>only</u> the high intensity light source box which is of concern. Existing boxes (Uncertified Equipment) display a warning notice stating it must not be used in the presence of combustible gases.



ARROW 'X' INDICATE DIRECTION OF ENTRY
OF THE MIRROR/LIGHT ASSEMBLY IN THE PLANE
OF THE VANE LOCKING PINS.
(SEE FIG. 3 HEAT SHIELD APERTURES)

Inspection Areas
Figure 601

Conditions of use of such equipment in a Zone 2 area in strict accordance with procedures (i.e. using gas monitors, etc.) would impose a considerable maintenance/operational burden.

An acceptable relaxation of this situation has been agreed following consultation/borescope demonstration with the Fire Protection Department; although relaxed, adequate safety standards and legal aspects are maintained provided the following precautions are adhered to.

(2) Engines, Installed or near an aircraft

(a) Check aircraft fuel log to ensure it has not uplifted a wide cut fuel (Jet B) during the previous 20 hours of operation.

(b) Aircraft must not be transferring fuel.

(c) Working inside aircraft fuel tanks must not be in progress.

(d) Flammable Liquids with a flash point below 90°F (32°C) must not be used within the Remotely High Risk area - as defined in Section 5.2, EDP-P-FIRE 4.

(e) Spraying or use of Petroleum Based Adhesives must not be permitted.

(f) Liquid Petroleum Gases must not be used within the Remotely High Risk area.

(g) If highly flammable liquids are present and "Uncertified Equipment" needs to be used or if any of the above conditions cannot be met, then Section 5.3 of EDP-P-FIRE 4 must be vigilantly followed.

(h) Where applicable, Bonding must take place.

(3) Engines in Workshops

(a) Conditions (2)(d), (2)(e), (2)(f) and (2)(g) apply.

2. H.P. Turbine Nozzle Guide Vane Pin and Bolt Inspection

A. General.

The purpose of the following inspection is to check the vane locking pins for location and the retaining bolts for security. Secondly to detect any evidence of heat damage caused by release of a vane locking pin.

B. Equipment and Materials.

Light Source Box
Flexible Light Guide
Inspection Mirror
Rod 3 ft. long approx 1/2 in. dia.

NOTE: The mirror, rod and light guide are to be formed into an inspection device by assembling as shown in Fig.602 and securing with masking or other suitable tape.

C. Procedure.

(1) Open all nacelle doors (Ref.71-00-00, Servicing).

(2) Inspect pins and bolts in area A by both visual inspection and feel.

NOTE: Refer to figs.603 and 604 for pin and bolt locations and to fig.601 for lettered inspection areas in the plane of the locking pins/bolts.

(3) Visually inspect pins and bolts in area E, using the light guide for illumination.

(4) Insert the inspection device over the air conditioning pack in the direction of arrow 'X' and inspect area C as follows:-

(a) Visually inspect with the aid of the mirror for the presence of pins and bolts where possible.

(b) Inspect the roof of the nacelle above the pins for evidence of overheating. Pay particular attention to the tantalum heatshield. (See Fig.605). The shield runs forward from just aft of the pin locations. It is normally a satin silver finish and any discolouration, which may range from very light brown through black to a white powdery appearance, must immediately be reported to Propulsion Engineering.

(c) Inspect for evidence of overheating in area D.

R B

(5) Insert the inspection device upwards between the engine and centre wall in the plane of the pins and inspect area E as follows:-

(a) Where possible visually inspect with aid of the mirror for the presence of pins and bolts.

(6) Inspect the centre wall and as far across the nacelle roof as possible for overheating. On stainless steel ducting or pipes look for brown or blue discolouration.

(7) Inspection Findings

(a) If a vane locking pin has been released the effects of the consequential heat damage to the local area MUST be discussed with PROPULSION ENGINEERING at LONDON before the aircraft may be declared serviceable.

(b) If a pin retaining bolt P/No.B417083 has failed but the pin has remained in position and the broken piece of thread has remained in position proceed as follows:-

(b.1) Remove the remaining portion from the casing.

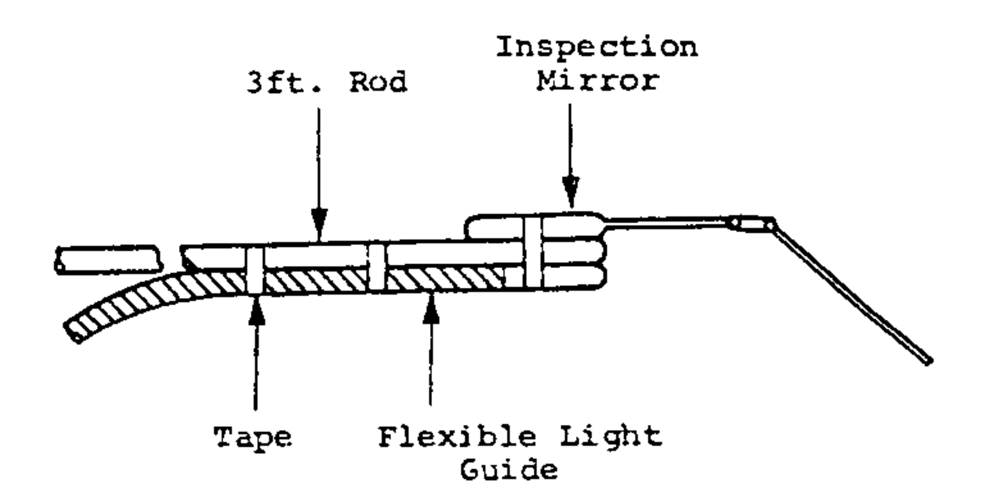
(b.2) Clean the threads in the casing to remove all traces of existing lubricant, using a cotton swab soaked in GENKLENE Code MCCL 0108.

(b.3) Fit a new bolt from Stores (P/No.B 417083). Lubricate bolt thread with Aeroshell 8 Grease, Code NFLA 6007 and torque load to 60-75 lb.in. Wire lock to nearest bolt.

(b.4) Record bolt change and position in casing (See Fig.604).

(b.5) At outstations, if a new bolt is not available, one may be robbed from a spare engine, but the thread must be thoroughly cleaned and closely inspected before use.

(c) If a pin retaining bolt P/No.B417083 has failed and the broken thread has come out leaving an open hole but the pin has remained in position, proceed as follows:-



CMR 72 50 00 6 BAMO

HP Turbine Nozzle Guide Vane Pin
& Bolt - Inspection
Figure 602

(c.1) Carry out a detailed visual inspection of the engine bay heat shields, structure, systems and equipment for signs of heat discolouration and mechanical damage.

(c.2) If no damage is found, replace the bolt as in (b.2) (b.3) (b.4) and (b.5).

(c.3) If any damage is found it must be discussed with PROPULSION ENGINEERING at LONDON before the aircraft may be declared serviceable.

(d) If a vane segment retaining bolt P/No.B466647 or B437144 is missing carry out a detailed visual inspection of the heat shield, bay structure, systems and equipment in the surrounding area and apply the following acceptance criteria:

(d.1) Up to a total of four bolts broken or

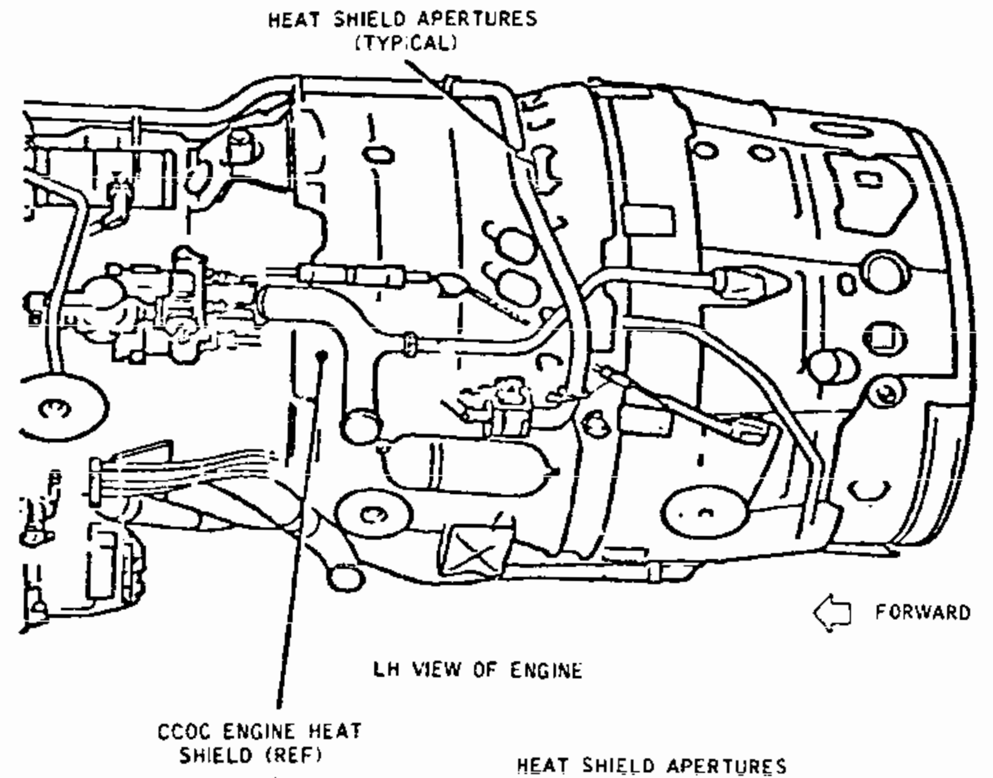
missing provided that no two are from adjacent positions and that none of the broken or missing bolts are in the top nine positions - engine acceptable subject to repeat inspections.

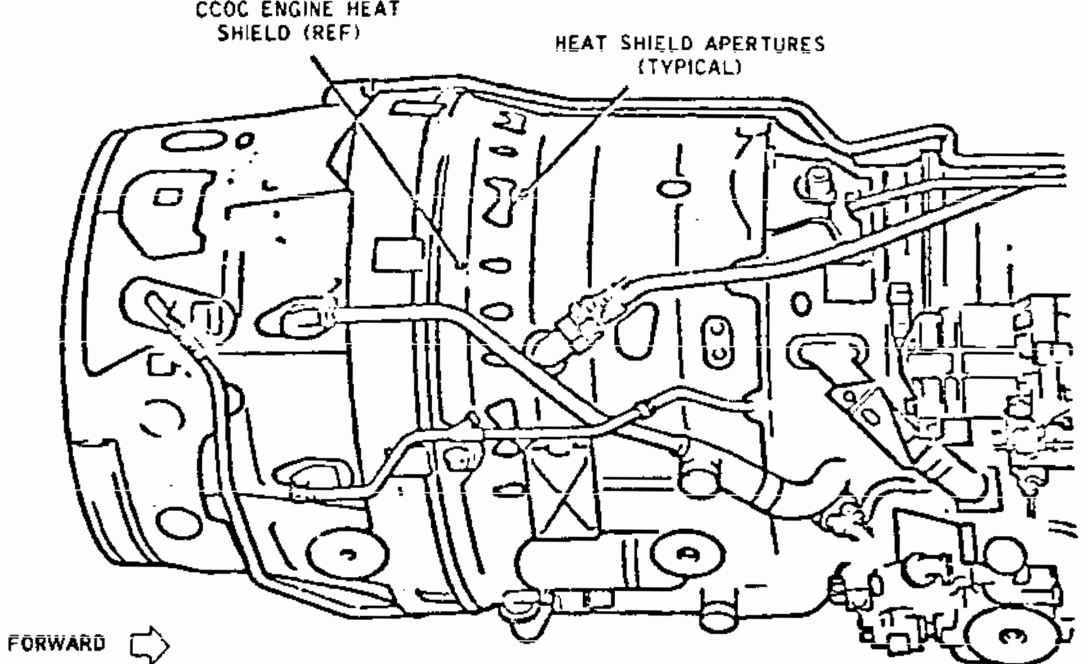
(d.2) Any broken or missing bolts in the top nine bolt positions or more than four bolts or two adjacent bolts broken or missing - engine not acceptable and must be removed for repair.

(e) If no damage is found no further action is required.

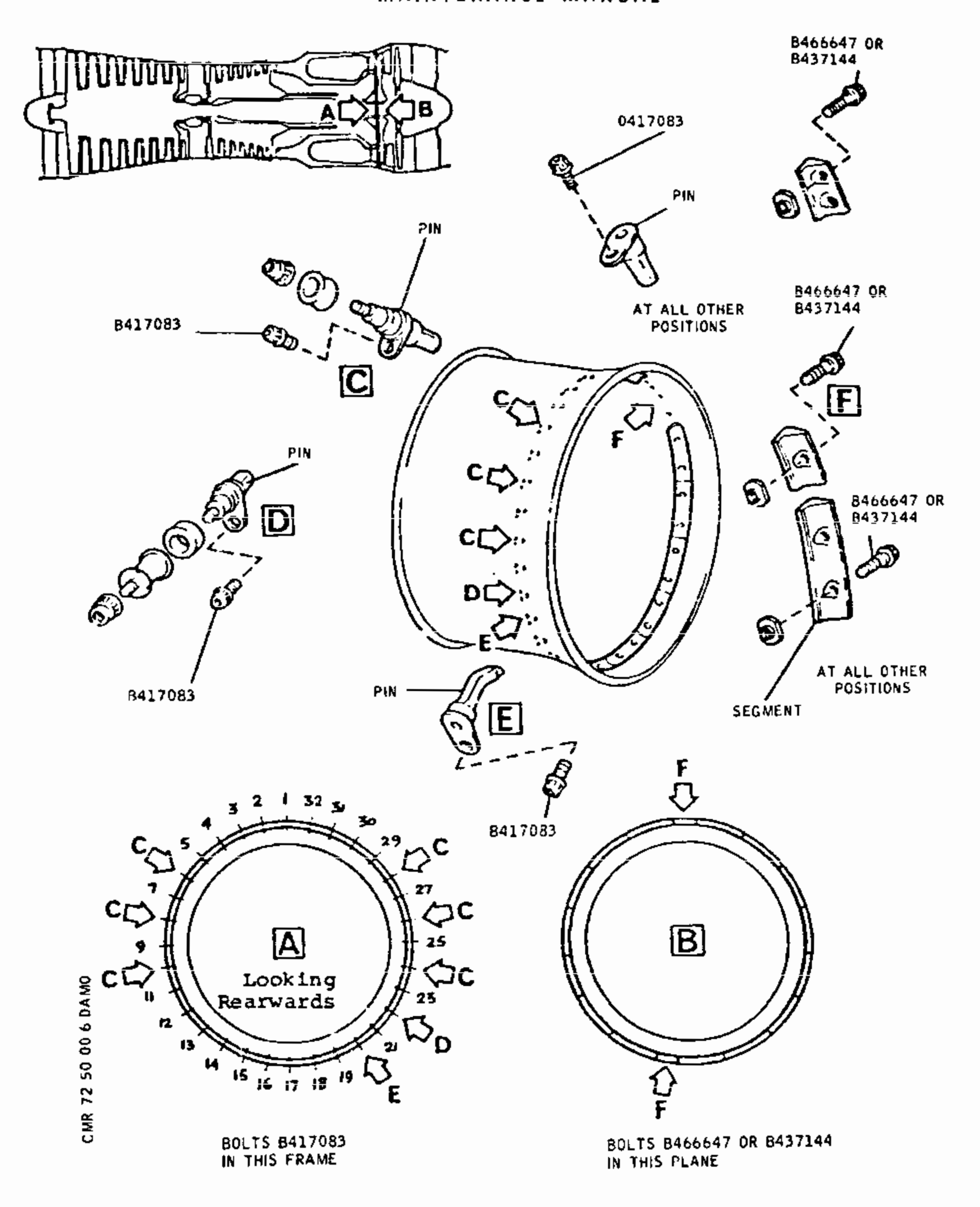
(f) Close all nacelle doors (Ref.71-00-00, Servicing).

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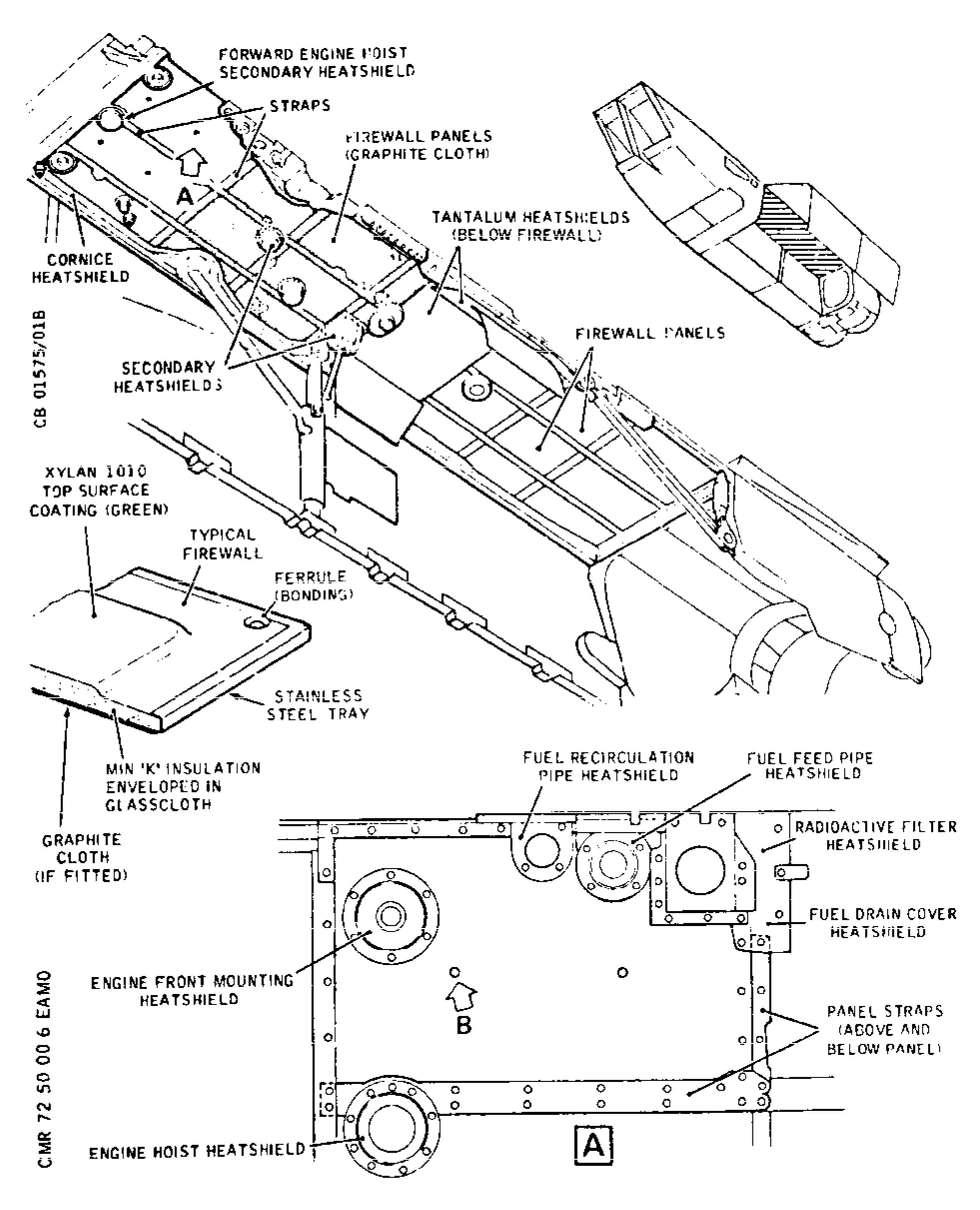




CCOC Engine Heat Shield
Figure 603



Pin and Bolt Locations
Figure 604



Structure Heat Shields
Figure 605

HP TURBINE ASSEMBLY - DESCRIPTION AND OPERATION

1. General

The HP turbine assembly is formed by a ring of nozzles and a turbine rotor with its supporting bearing as shown in the illustration (Ref. Fig. 001).

2. Nozzles

The nozzles are in the form of a segmented ring located in the nozzle vane support cone forward of the turbine disk. Each segment incorporates two vanes and has lugs at the base that engage with slots in a locating ring bolted to the support cone. Nozzle locking pins and abutment segments held by the combustion chamber outer case, retain the outer periphery of the ring in the combustion chamber. Each vane contains passages for internal cooling air flow.

3. Rotor

The rotor consists of a bladed disk, a hub and front and rear labyrinths. Shrouded turbine blades are located in fir-tree form slots, equally disposed around the periphery of the disk, and are retained at the rear face by lugs on the disk edge and the engagement of locking plates with tangs on the blades. When the engine is static, slight clearance exists between the fir-tree form location slots and the blade roots, but because the shrouded blade tips are in peripheral contact the clearance is not apparent. The hub is secured to the HP compressor drive shaft rear end and the disk, located by Hirth serrations is secured to the hub rear face by bolts and nuts which also attach the labyrinth seals to the disk front and rear faces. Holes run lengthwise through each blade, from root to shrouded tip, to provide passages for cooling air flow.

4. Bearing

The bearing is located forward of the rotor hub and turbine disk and is housed in the turbine bearing front support. The support is secured between the rear of the HP compressor diffuser case assembly and the HP turbine nozzle vane support cone and incorporates air passages for turbine and nozzle cooling and labyrinth seal pressurizing.

5. Operation of the Turbine Assembly

The nozzle and turbine rotor act together to convert a portion of the gas flow energy into shaft power to drive the HP compressor rotor assembly and associated accessories.

CR 31353/00A

BEARING FRONT SUPPORT

A

HP COMPRESSOR DIFFUSER CASE (INNER)

HP TURBINE BLADE

COMBUSTION CHAMBER

NOZZLE LOCKING PIN

LOCKING PLATE

HP TURBINE DISK

HP TURBINE NOZZLE VANE

FRONT LABYRINTH

REAR LABYRINTH

LOCATING RING

A

HIRTH SERRATIONS

NOZZLE VANE SUPPORT CONE

HP TURBINE BEARING

BEARING FRONT SUPPORT

HP COMPRESSOR DRIVE SHAFT

HP TURBINE HUB

HUB RETAINING NUT

CMR 72 51 00 0 AAMO

HP Turbine Assembly
Figure 001

When the engine is running, the clearance between the fir-tree form location slots in the disk and the blade roots is taken up.

HIGH PRESSURE (HP) TURBINE ASSEMBLY - INSPECTION/CHECK

1. General

The HP turbine rotor blades leading edges are examined without dismantling the engine by the use of an optical inspection probe inserted through a sealed port located in the combustion chamber outer case (CCOC) rearward of the thermocouple junction box. The trailing edges of the turbine rotor blades are accessible through sealed ports located in the CCOC rearward of the fuel drains tank.

The leading edge regions of the HP turbine nozzle vanes are examined by the use of a probe inserted through three inspection ports provided in the CCOC.

A. Read the following information regarding the use of borescope equipment. This outlines how these may affect safety and their classification relative to our Procedures. The precautions listed must be complied with.

(1) Background and Description

Borescope inspections of internal engine components are frequently carried out. These inspections, when conducted with equipment utilising a light source box, now require additional precautions to be taken to eliminate risk of hazard when used in an environment potentially containing combustible gases.

Engines installed or near an aircraft, inside or outside a hangar, fall within the compass of this environment. Uninstalled engines in workshops may also be in a hazardous environment.

These environments are termed "Zone 2" areas but dedicated Zone 2 certification for equipment is not granted by the Regulatory Authority and it is deemed "UNCERTIFIED EQUIPMENT".

A borescope kit comprises of several pieces of equipment but it is only the high intensity light source box which is of concern. Existing boxes (Uncertified Equipment) display a warning notice stating it must not be used in the presence of combustible gases.

Conditions of use of such equipment in a Zone 2 area in strict accordance with procedures (i.e. using gas monitors, etc.) would impose a considerable maintenance/operational burden.

An acceptable relaxation of this situation has been agreed following consultation/borescope demonstration with the Fire Protection Department; although relaxed, adequate safety standards and legal aspects are maintained provided the following precautions are adhered to.

(2) Engines, Installed or near an aircraft

(a) Check aircraft fuel log to ensure it has not uplifted a wide cut fuel (Jet B) during the previous 20 hours of operation.

(b) Aircraft must not be transferring fuel.

(c) Working inside aircraft fuel tanks must not be in progress.

(d) Flammable Liquids with a flash point below 90°F (32°C) must not be used within the Remotely High Risk area - as defined in Section 5.2, EDP-P-FIRE 4.

(e) Spraying or use of Petroleum Based Adhesives must not be permitted.

(f) Liquid Petroleum Gases must not be used within the Remotely High Risk area.

(g) If highly flammable liquids are present and "Uncertified Equipment" needs to be used or if any of the above conditions cannot be met, then Section 5.3 of EDP-P-FIRE 4 must be vigilantly followed.

(h) Where applicable, Bonding must take place.

(3) Engines in Workshops

(a) Conditions (2)(d), (2)(e), (2)(f) and (2)(g) apply.

2. Tools and Equipment

Probe	) Part of kit PE.35891	(	PE.24262
Sleeve (retained on probe)...	)	(	S3S.11209000
Light transmitting cable ...	)	(	PE.24099
Probe eyepiece...			PE.15969
Light source box			PE.24304
Probe	) Part of kit PE.15889	(	PE.15862
Transformer	)	(	PE.24310

3. Terminology for Damage

A. Apply the following definitions to the terms used to describe damage:

(1) Break. A separation by force into two or more pieces.

(2) Crack. Visible partial separation of material which may progress to a complete break (Ref.(1)).

(3) Distortion. Excessive deformation of the original contour of the part, (associated terms, buckle, depression, twist, warp).

(4) Rubbed. To move with pressure or friction against another part.

(5) Spalled. Sharply roughened area characterized by progressive chipping away of surface material. (Not to be confused with flaking). Usual causes are surface cracks, inclusions or any similar surface injury causing a progressive breaking away of the surface under load.

(6) Torn. Separation by pulling apart.

4. Examination of HP Turbine Rotor Blades and Nozzle Vanes

A. Prepare Engine for Examination.

(1) Open engine bay front and rear doors (Ref.71-00-00, Servicing).

(2) Install HP rotating assembly hand turning equipment (Ref.72-09-01).

B. Remove Flanged Sealing Bar Assemblies.

(1) Remove flanged sealing bar at thermocouple termination junction box position (Ref.Fig.601).

(a) Remove bolts securing cover plate and flanged sealing bar and detach cover plate.

(b) Withdraw sealing bar from engine.

(2) Remove one of the flanged sealing bars at rear of drains tank position (Ref.Fig.602).

<u>NOTE:</u> There are two configurations of turbine inspection port access at rear of drains tank position (Ref.Fig.602).

(a) Remove bolts securing cover plate and flanged sealing bar and detach cover plate.

(b) Withdraw sealing bar from engine.

(b1) On engines to pre S.B. OL.593-72-58 standard, remove any deposits of jointing compound from abutment surfaces (Ref. 70-00-08).

(b2) On engines to S.B. OL.593-72-58 standard remove gasket.

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A

THERMOCOUPLE TERMINATION JUNCTION BOX

A

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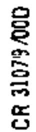
COMBUSTION CHAMBER OUTER CASE

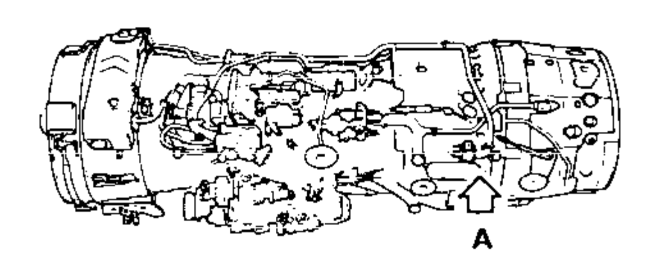
HEAT INSULATING SHIELD

FLANGED SEALING BAR

COVER PLATE

Inspection Port (Rotor Blades Leading Edges)
Figure 601





DRAINS TANK

A

A

COMBUSTION CHAMBER OUTER CASE

GASKET (SB 72-58)

FLANGED SEALING BAR

COVER PLATE

COMBUSTION CHAMBER OUTER CASE

BLANKING PLATE

ALTERNATIVE STANDARD

Inspection Ports (Rotor Blades Trailing Edges)
Figure 602

CR 31670/00B

FORWARD

A

HP COMPRESSOR
DIFFUSER CASE

COMBUSTION CHAMBER OUTER CASE
(UNDER HEATSHIELDS)

BLANKING COVER

A

BLANKING COVER

B

SPACER PLATE
(PRE S.B. 72-62)

BLANKING COVER

GASKET

C

COMBUSTION CHAMBER OUTER CASE
(UNDER HEATSHIELDS)

HP COMPRESSOR
DIFFUSER CASE

FORWARD

B

C

CMR 72 51 00 6 CAMO

Inspection Ports (Turbine Nozzles)
Figure 603

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C. Remove Blanking Covers from CCOC Inspection Ports (Ref. Fig. 603).

(1) Remove attachment bolts and blanking cover from the CCOC left hand inspection port (detail A).

(2) Remove attachment bolts and cover from right hand inspection port together with spacer plate on engine to S.B.OL.593-72-8629-256 standard (detail B).

NOTE: If difficulty was experienced in removal of bolts or cover, refer to S.B.OL.593-72-8629-256.

(3) Remove blanking cover from bottom inspection port (detail C).

(a) Position a container to catch any residual fuel.

(b) Remove bolts securing blanking cover to CCOC.

(c) Withdraw blanking cover and gasket (S.B.OL.593-72-58) from engine.

(d) Wipe fuel deposits from inspection port area.

D. Prepare and test optical inspection equipment (Ref. 72-09-03).

E. Examine Rotor Blades and Nozzle Vanes.

CAUTION : DO NOT MOVE LIGHT SOURCE BOX WHILE SWITCHED ON OR WITHIN 30 SECONDS OF SWITCHING OFF. BULB FILAMENT IS NOT SHOCK RESISTANT WHEN HOT.

(1) Commence examination using probe PE.24262, in conjunction with light source box PE.24304 and cable PE.24099, inserted through the ports in the CCOC (Ref. Fig. 601). Turn the engine as necessary to ensure full coverage of all surfaces to be examined.

(2) Record extent of any damage or debris found, using the terms given in paragraph 3 and by reference to the illustration (Ref. Fig. 604). If a photographic record of the damage is required, use the equipment and procedures detailed in 72-09-04.

CAUTION: RETAIN PROTECTIVE SLEEVE ON PROBE AT ALL TIMES EXCEPT WHEN REMOVAL IS ESSENTIAL FOR INSERTION OF PROBE OR ITS EFFECTIVE USE WHEN INSERTED.

(a) Insert probe and ensure free penetration.

(b) Switch on probe illumination and commence examination.

R NOTE: There are 87 HP turbine rotor blades per set.

(c) Carefully examine the leading edge region of the turbine rotor blades for damage, signs of blockage or evidence of debris wrapped around the leading edges. Check that each blade shroud middle - loaded abutment face has a bridge piece pad in correct abutment with the pad on the adjacent blade shroud. Change the probe position and vary the depth of insertion as necessary to obtain coverage.

(d) Change the probe position (Ref.Fig.602) and carefully examine the trailing edge region of the turbine rotor blades using the same probe insertion procedure.

NOTE: If the LP turbine Inspection/Check procedure (Ref.72-52-00) is to be carried out, phase it in with the sequence stated in paragraph (d).

(e) On completion of examination switch off illumination and withdraw probe.

(f) Stow optical inspection equipment (Ref.72-09-03).

(g) Assess the acceptability of any damage found by comparison of the examination results with the acceptance standards stated in paragraph 5.

(3) Continue with examination of the HP turbine nozzle vanes using probe PE.15862, in conjunction with transformer PE.24310, inserted through the CCOC ports (Ref.Fig.603).

WARNING: QUARTZ IODINE BULBS MUST NOT BE HANDLED IN SERVICE. HANDLING OF BULB WILL CAUSE SURFACE CONTAMINATION WHICH MAY CAUSE BULB TO SHATTER. CHECK PERIODICALLY AND REMOVE RESIDUAL FUEL DRAINAGE AT LOWER PORT POSITION AND FROM PROBE. FUEL COULD ENTER EYES DURING EXAMINATION SEQUENCE.

CAUTION: DO NOT USE FORCE TO EFFECT PROBE ENTRY AND PREVENT PROBE FROM BECOMING DENTED OR BENT. INVESTIGATE ANY OBSTRUCTION TO PROBE PENETRATION.

(a) Insert probe through inspection port, switch on probe illumination and commence examination of nozzle vanes for damage and entrapped debris.

(b) Record extent of any damage found using the terms given in paragraph 3 and by reference to the illustrations. If a photographic record of the damage is required, use the equipment and procedures detailed in 72-09-04.

NOTE: If the combustion chamber Inspection/Check procedure (Ref. 72-41-01) is to be carried out, phase it in with this sequence.

(c) When debris is found obstructing the gas flow passages of the nozzle annulus, estimate and record the following data.

(i) The total, forward facing, area of the blockage(s).

(ii) The maximum height (h) of the blockage. measure the blockage radially, in line with the adjacent vanes, from the inner to the outer edge.

(iii) Take the annulus height (H) as 4.2 in. and calculate h.H. Use the value obtained to assess acceptability (Ref.paragraph 6.B.).

(d) On completion of examination, switch off illumination and withdraw probe.

(e) Stow optical inspection equipment (Ref.72-09-03).

(f) Assess the acceptability of any damage or blockage found by comparison of examination results with the acceptance limits stated in paragraph 6.

F. Install Flanged Sealing Bar Assemblies.

(1) Install flanged sealing bar at thermocouple termination junction box position (Ref. Fig.601).

R CAUTION: IT IS ESSENTIAL THAT LUBRICANT 'C'
R IS USED ON THE APPLICABLE BOLTS/NUTS
R DURING ASSEMBLY
R (REF. SB.OL.593-72-9044-436).

(a) Apply lubricant C to bolts (Ref. 70-00-01, Servicing and Storage Materials).

(b) Insert flanged sealing bar into engine, position cover plate and secure assembly with two bolts torque-tightened to 100 lbf in (11,5 N.m).

(c) Wire-lock bolts together.

(2) Install flanged sealing bar in position from which removed at rear of drains tank (Ref. Fig.602).

R CAUTION: IT IS ESSENTIAL THAT LUBRICANT 'C'
R IS USED ON THE APPLICABLE BOLTS/NUTS
R DURING ASSEMBLY
R (REF. SB.OL.593-72-9044-436).

(a) Apply lubricant C to bolts (Ref. 70-00-01, Servicing and Storage Materials).

(b) On engines to pre S.B. OL.593-72-58 standard, apply jointing compound A (Ref. 70-00-08) to abutment surfaces and insert sealing bar into engine.

(c) On engines to S.B. OL.593-72-58 standard, position a gasket on mounting boss and insert flanged sealing bar into engine.

(d) Position cover plate on sealing bar and secure with two bolts torque-tightened to 100 lbf in (11,5 N.m).

(e) Wire-lock bolts together.

G. Install Blanking

(a) Assemble blanking cover to left hand inspection port (Detail A).

R CAUTION: IT IS ESSENTIAL THAT LUBRICANT 'C'
R IS USED ON THE APPLICABLE BOLTS/NUTS
R DURING ASSEMBLY.
R (REF. SB.OL.593-72-9044-436).

(a) Apply lubricant C to bolts (Ref.70-00-01, Servicing and Storage Materials).

(b) Secure the cover with six bolts torque-tightened to between 100 lbf in (11,5 Nm).

(c) Wire-lock bolts together.

(2) Assemble blanking cover to right hand inpsection port.

R CAUTION: IT IS ESSENTIAL THAT LUBRICANT 'C'
R IS USED ON THE APPLICABLE BOLTS/NUTS
R DURING ASSEMBLY.
R (REF. SB.OL.593-72-9044-436).

(a) Apply lubricant C to bolts (Ref.70-00-01).

(b) Locate the cover on the port, together with the spacer plate on engines to pre-SB OL593-72-62/ SB OL593-72-8629-256 standard (Detail B) and retain in position with six bolts lightly tightened.

(c) Torque tighten the six bolts to 100 lbf in (11,5 N.m).

(d) Wire-lock the bolts together.

(3) Assemble blanking cover to bottom inspection port, (detail C).

R CAUTION: IT IS ESSENTIAL THAT LUBRICANT 'C'
R IS USED ON THE APPLICABLE BOLTS/NUTS
R DURING ASSEMBLY
R (REF. SB.OL.593-72-9044-436).

(a) Apply lubricant C to bolts.

(b) Locate the cover on the engine with a gasket (SB OL593-72-58) interposed, and secure with six bolts torque-tightened to 100 lbf in (11,5 N.m).

(c) Wire-lock the bolts together.

H. Complete the Installation.

CAUTION: FAILURE TO CORRECTLY RE-ASSEMBLE THE COVER, INCLUDING THE USE OF A NEW GASKET, WILL LEAD TO RAPID LOSS OF ENGINE OIL CONTENTS DURING FLIGHT.

(1) Remove HP rotating assembly hand turning equipment (Ref. 72-09-01).

(2) On completion of work close engine bay doors (Ref. 71-00-00, Servicing).

5. Rotor Blades Acceptance Standards (Ref. Fig.604)

A. Blade Aerofoil Damage.

(1) Impact damage is acceptable in any number of blades provided that:

(a) Zone A

(a1) Damage is smoothly contoured and free from cracks.

(a2) Damage marks have a diameter not greater than 0.07 in. (1,8 mm) and,

(a3) Are not deeper than 0.005 in. (0,13 mm) and,

(a4) The distance between any two damage marks is not less than 0.5 in. (12,7 mm).

(a5) Trailing edge deformation does not exceed 0.01 in. (0,25 mm).

(a6) Damage does not penetrate through the aerofoil to any cooling hole.

(b) Zone B

(b1) Damage is smoothly contoured and free from cracks.

(b2) Damage marks have a diameter not greater than 0.1 in. (2,5 mm) and,

(b3) Are not deeper than 0.01 in. (0,25 mm) and,

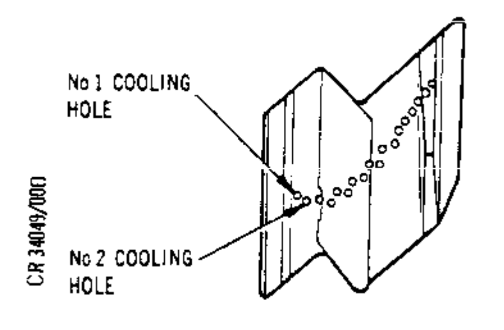
(b4) The distance between any two damage marks is not less than 0.5 in. (12,7 mm).

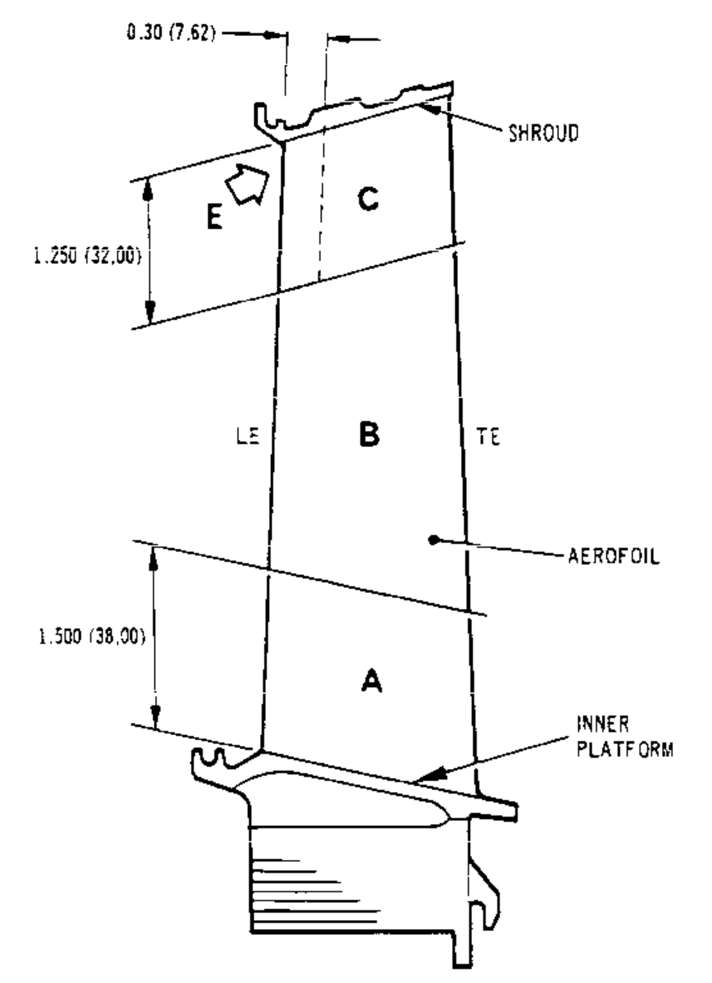
(b5) Trailing edge deformation does not exceed 0.02 in. (0,5 mm).

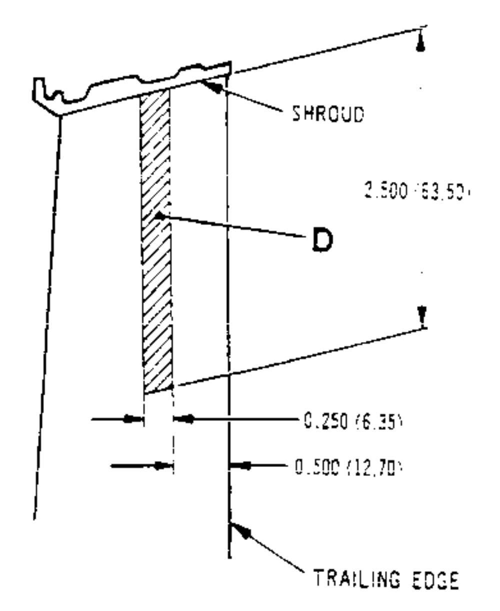
(b6) Damage does not penetrate through the aerofoil to any cooling hole.

(c) Zone C - Area within 0.3 in. (7,62 mm) of leading edge

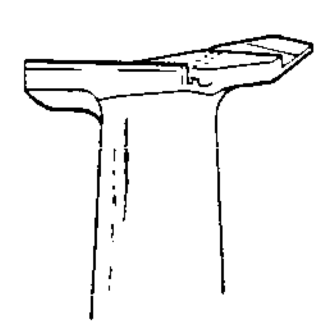
(c1) Any material separation relating to tears or loss of material is contained entirely within a deformed area.







NOTE. ZONE D IS APPLICABLE TO BOTH THE CONCAVE AND CONVEX FACES



TYPICAL COLLAPSE OF WALL SECTION INTO THE No 1 & No 2 COOLING HOLES



DIMENSIONS GIVEN ARE SHOWN THUS :- INCHES (MILLIMETRES)

HP Turbine Rotor Blades - Identification of Zones and Details of Wall Section Collapse
Figure 604

(c2) There are no signs of overheating or loss of material resulting from corrosion.

(c3) Crazing or multiple cracking of the surface coating is within, or in the immediate vicinity of material deformation.

(c4) Damage marks do not exceed 0.25 in. (6,35 mm) in any direction and,

(c5) Are not deeper than 0.025 in. (0.635 mm) and do not penetrate into any cooling holes.

(c6) Damage marks are separated by a distance of not less than 0.25 in. (6,35 mm).

(c7) Leading edge distortion does not exceed 0.02 in. (0,508 mm).

(d) <u>Zone C - Area rearward of 0.3 in. (7,62 mm) from leading edge</u>

(d1) Damage is smoothly contoured and free from cracks.

(d2) Damage marks have a diameter not greater than 0.125 in. (3,2 mm) and,

(d3) Are not deeper than 0.015 in. (0,4 mm) and,

(d4) Damage marks are separated by not less than 0.125 in. (3,2 mm).

(d5) Trailing edge deformation does not exceed 0.03 in. (0,8 mm).

(e) If any of the above limits are exceeded, refer to paragraph (2) for extended limits.

R B (2) Impact damage which exceeds the limits stated in
R B paragraph (1) must be referred to Propulsion
R B Engineering so that monitoring requirements may
R B be determined.

(a) <u>Zone A</u> - the following damage is acceptable for a maximum of eight flights provided that the unaffected blades are undamaged or are within the acceptable limits stated in paragraph (1).

(a1) Not more than five blades are affected.

(a2) There are no cracks/tears.

(a3) Damage marks have a diameter not greater than 0.1 in. (2,5 mm) and,

(a4) Are not deeper than 0.01 in. (0,25 mm) and,

(a5) The distance between any two damage marks is not less than 0.15 in. (3,8 mm).

(a6) Trailing edge deformation does not exceed 0.02 in. (0,5 mm).

(b) Zone B - the following damage is acceptable for a maximum of eight flights provided that the unaffected blades are undamaged or are within the acceptable limits stated in paragraph (1).

(b1) Not more than five blades are affected.

(b2) Tears are not longer than 0.05 in. (1,3 mm) and have no cracks running into the undamaged blade material.

(b3) Damage marks have a diameter not greater than 0.125 in. (3,2 mm) and,

(b4) Are not deeper than 0.015 in. (0,4 mm).

(b5) The distance between any two damage marks is not less than 0.15 in. (3,8 mm).

(b6) Trailing edge deformation does not exceed 0.03 in. (0,8 mm).

(c) Zone C - Area within 0.3 in. (7,62 mm) of leading edge - subject to periodic inspection at 360 hour intervals damage is acceptable on any number of blades provided that:

(c1) Any material separation relating to tears or loss of material is contained entirely within a deformed area.

(c2) There are no signs of overheating or loss of material resulting from corrosion.

(c3) Crazing or multiple cracking of the surface

coating is within, or in the immediate vicinity of material deformation.

(c4) Damage marks do not exceed 0.25 in. (6,35 mm) in any direction and,

(c5) Are not deeper than 0.05 in. (1,27 mm) except where cooling holes have been penetrated, which is acceptable without measurement.

(c6) Damage marks are separated by a distance of not less than 0.25 in. (6,35 mm).

(c7) Leading edge distortion does not exceed 0.05 in. (1,27 mm).

(c8) If any of the above limits are exceeded, refer to paragraph (d) for extended limits.

(d) Zone C - Area within 0.3 in. (7,62 mm) of leading edge - subject to periodic inspection at 75 hour, minus 0 plus 15 hour intervals, damage is acceptable provided that:

(d1) Any material separation relating to tears or loss of material is contained entirely within a deformed area.

(d2) There are no signs of overheating or loss of material resulting from corrosion.

(d3) Crazing or multiple cracking of the surface coating is within, or in the immediate vicinity of material deformation.

(d4) Damage marks do not exceed 0.5 in. (12,725 mm) along the leading edge and 0.25 in. (6,35 mm) measured rearwards from the leading edge and,

(d5) Leading edge distortion does not exceed 0.05 in. (1,27 mm).

(d6) Not more than 10 blades have damage in excess of the 360 hour limits stated in paragraph (c).

NOTE: There is no limit on depth of damage contained within this area.

(e) <u>Zone C - Area rearward of 0.3 in. (7,62 mm) from leading edge</u> - the following damage is acceptable for a maximum of eight flights provided that the unaffected blades are undamaged or are within the acceptable limits stated in paragraph (1).

(e1) Not more than five blades are affected.

(e2) Tears are not longer than 0.1 in. (2,5 mm) and have no cracks running into the undamaged blade material.

(e3) Isolated heavy impact and damage marks, which penetrate through to cooling holes, other than No.1, have a diameter not greater than 0.1 in. (2,5 mm).

(e4) Damage to the trailing edge, is not deeper than 0.1 in. (2,5 mm) into the aerofoil, and extends no further than 0.5 in. (12,7 mm) along the trailing edge.

(e5) Trailing edge deformation does not exceed 0.04 in. (1 mm).

R (3) Aerofoil collapse into the No.1 and 2 cooling holes
R (Fig.604).

R (a) Collapsed blades may be accepted unless there
R is evidence, associated with the collapsed
R area, of cracking, sharp edged impact damage or
R deterioration since last inspection, but must
R be changed when next exposed.

R (4) Cracks are acceptable in any number of blades subject to the following limits.

(a) Subject to a periodic inspection at intervals of 360 hours, one crack is acceptable in Zone D of either or both of the concave and convex faces of a blade aerofoil (Ref. Fig. 604) provided that it is within the following limits. Zone D is established from the blade shroud and the trailing edge of both surfaces.

(a1) The cracks is not more than 1.25 in. (32,00 mm) long and does not extend more than 2.5 in. (63,5 mm) from the shroud.

(a2) The crack runs approximately parallel to the trailing edge and is more than 0.5 in. (12,79 mm) and less than 0.75 in. (19.05 mm) from it.

(b) Cracks not within the stated limit or not defined in paragraph (a) are not acceptable.

B NOTE: Experience has indicated that, due to
B casting porosity, blades are particularly
B prone to cracking transversely at the
B mid-span quarter chord location on the
B concave airfoil surface. Particular
B attention should therefore be paid to
B this area when carrying out blade
B inspection.

R (5) Corrosion/Sulphidation.

(a) Black/grey corrosion eruption area on the leading edge is acceptable provided that:

(a1) It is not wider than 0.125 in. (3,2 mm) and,

(a2) It is within 1.25 in. (32 mm) of the blade inner platform and,

(a3) The surface is not spalled or cracked and,

(a4) The corrosion is periodically checked at intervals not exceeding 90 hours of engine flight time.

(b) Black/grey or green corrosion eruption area on the aerofoil concave surface is acceptable provided that:

(b1) It is not greater than 0.5 in. (12,7 mm) by 1 in. (25 mm) and,

(b2) It is within 2 in. (50 mm) of the blade inner platform and,

(b3) The surface is not spalled or cracked.

(c) Black/grey corrosion eruption area on the leading edge exceeding the limitations stated in (a) is acceptable for a maximum of eight flights only, provided that:

(c1) It is not greater than 0.2 in. (5 mm) wide and 0.75 in. (19 mm) long and,

(c2) Cracked or spalled areas in the corrosion layer do not extend into the unaffected material next to the corrosion area.

(d) Black/grey or green corrosion eruption area on the aerofoil concave surface exceeding the limitations stated in (b) is acceptable for a maximum of eight flights only, provided that:

(d1) It is not greater than 0.75 in. (19 mm) by 1.5 in. (38 mm) and,

(d2) It is within 2.5 in. (63 mm) of the blade inner platform and,

(d3) The surface is not spalled or cracked.

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B. Blade Shroud Damage.

R B NOTE: Any blade shroud damage must be referred to
R B Propulsion Engineering so that monitoring
R B requirements may be determined.

(1) Impact damage which is smoothly contoured and free from cracks is acceptable provided that:

(a) Damage marks have a diameter not greater than 0.125 in. (3,2 mm) and,

(b) Are not deeper than 0.015 in. (0,4 mm).

(c) Shroud side face and/or shroud trailing edge distortion does not exceed 0.03 in. (0,8 mm).

(d) Shroud abutment pads are intact.

(e) Cracks from bridge piece pad short braze face on the underside of the shroud in parent material are directed towards the aerofoil fillet radius and do not progress beyond it.

(2) Outward distortion of extreme edges of bridge pieces (Ref. Fig. 605) is acceptable provided that if there are signs of a rub between the bridge piece corners and the HP turbine nozzle guide vane tip seal liner extension inner face.

(a) There are no signs of cracking or material missing from the visible liner extension.

(b) All bridge piece contact faces appear intact.

(c) The distortion and rubbing is monitored by periodic inspection at 360 hour intervals.

NOTE: The edges of the bridge pieces can be viewed, through the blade trailing edge inspection port, by sighting between the trailing edge of the blade shroud and the HP nozzle vane tip seal liner. The visible HP nozzle vane tip seal liner will also be the one most likely to sustain a rub from the bridge pieces because it is at the bottom of the engine.

(3) Shroud distortion which has resulted in a rub between

the edge of the bridge piece and the HP nozzle vanes tip seal liner inner face (Ref. Fig. 605), is acceptable for a maximum of eight flights only, provided that:

(a) All bridge piece abutment faces are still in contact.

(4) Outward distortion of the shroud trailing edge (Ref. Fig. 605) is acceptable provided that:

(a) The inner edge of the distorted shroud trailing edge does not extend beyond the outer edge of the trailing edge on the adjacent blade shroud to form a clearance or,

(b) If the shroud trailing edge distortion exceeds the limits stated in paragraph (a):

(b1) The clearance between the shroud trailing edge is not greater than 0.03 in. (0,8 mm) and,

(b2) The damage is acceptable for a maximum of eight flights only.

(5) Light impact damage on shroud abutment face is acceptable provided that:

(a) Bridge piece pad abuts correctly with the pad on the adjacent blade shroud.

(6) Heavy impact damage on the shroud which results in release of the abutment face pad, or causes ineffective contact between the pad and the adjacent blade, is acceptable for a maximum of eight flights only, provided that:

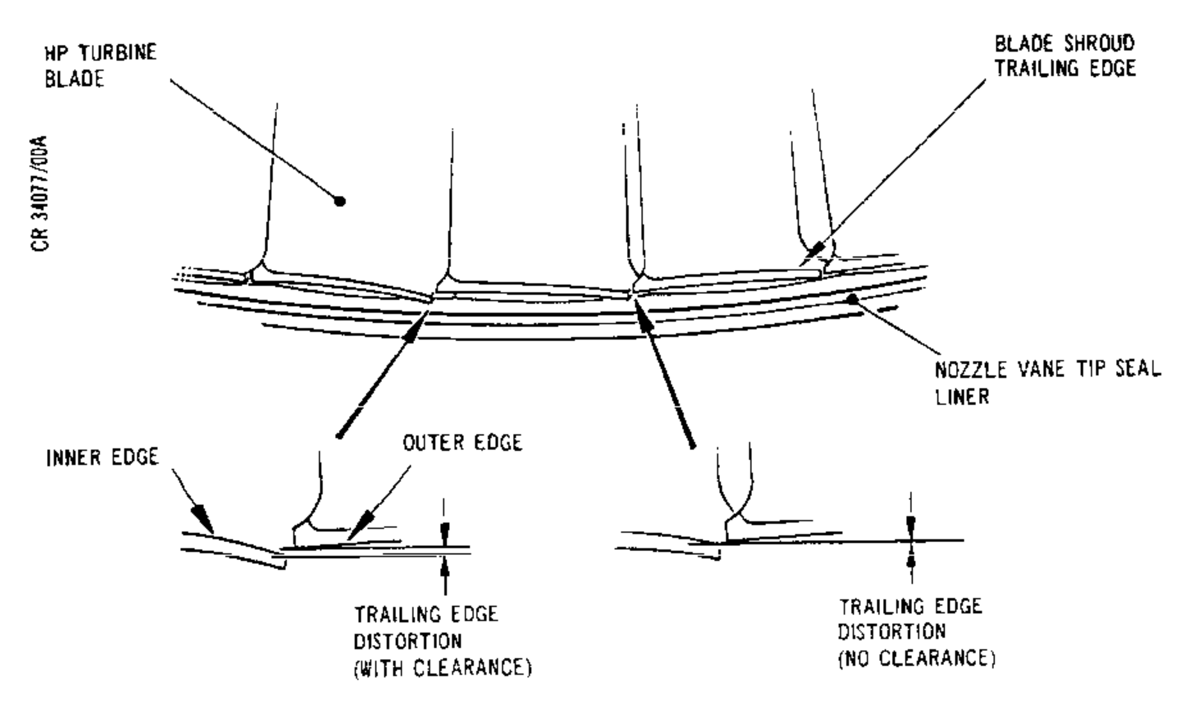
(a) Not more than one blade is affected.

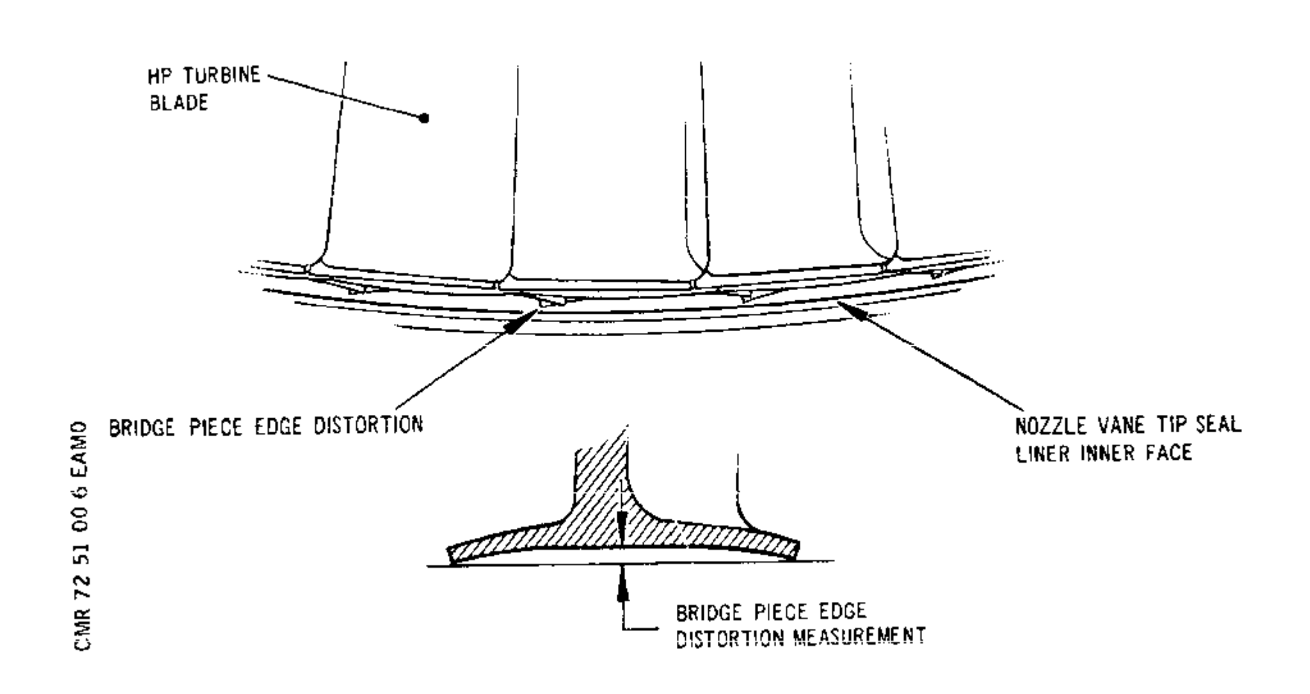
(7) Impact damage on the shroud which results in release of the abutment face pad, is acceptable for a maximum of eight flights only, provided that:

(a) Not more than two blades are affected and,

(b) The two damaged blades are separated by at least 15 undamaged blades and,

(c) The impact damage is within the limitations stated in paragraphs (1), (2) and (3).





Examples of Blade Shroud Distortion
Figure 605

6. Nozzle Vanes Acceptance Standards

A. Vane Damage.

(1) The following damage is acceptable on any number of vanes.

(a) Chipping of pack aluminised coating.

(b) Areas of corrosion and/or erosion over the entire vane surface provided that there are no associated cracks (except those defined in paragraph (c)).

(c) Multiple cracking of vane leading edge (often short, closely spaced and hairline in appearance and associated with erosion/corrosion) - any number of cracks up to 0.5 in. (12,7 mm) long.

R (d) Single crack extending towards the vane leading edge from beyond the point of vision but terminating more than 0.5 in. (12,7 mm) away from the leading edge (excluding cracks defined in paragraphs (c) and (d)).

R (e) Impact damage on the vane leading edges and aerofoil surfaces provided that identations are less that 0.5 in. (12,7 mm) (with or without puncturing of the vane material) and there is no evidence of burning.

B. Blockage/Obstruction by Debris.

(1) Using the h/H value calculated, apply the estimated blockage area (previously recorded) and determine the blockage number from the graph (Ref.Fig.606).

(2) From the blockage number (B. No.) obtained, determine the acceptability of the engine.

(a) B. No. up to 1.50 - acceptable provided that the primary damage is within acceptable limits and the blockage debris is removed on the first removal of the engine.

(b) B. No. greater than 1.50 - not acceptable. Remove engine for module removal and additional inspection as detailed in the Heavy Maintenance manual, 72-00-00, Appendix 6.

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h = ESTIMATED MAXIMUM BLOCKAGE HEIGHT
H = ANNULUS HEIGHT, 4.20 INCHES

$\frac{h}{H} = 1.00$

$\frac{h}{H} = 0.75$

$\frac{h}{H} = 0.50$

$\frac{h}{H} = 0.33$

BLOCKAGE NUMBER

0 1 2 3 4 5 6 7 8

0 2 4 6 8 10 12 14 16 18 20

BLOCKAGE AREA (SQ IN)

R Blockage Number
Figure 606

7. Intrascope Inspection

B A. General

B The following British Airways procedure and equipment is
B given to enable an intrascope inspection to be made of
B internal engine components.

B B. Equipment and Materials

B (1) Intrascope Kit BAOD code HWAK 1043 with carrying case
B containing:-

B (a) Fibrelight guide cable BAOD code HZAC 1753.

B (b) Lateral view Endoprobe with focusing 8mm dia. x 19 ins long BAOD code HZAE 1279.

B (c) Right angle eyepiece for use with lateral view
B Endoprobe BAOD code HZAM 0409.

B (d) Forward view Endoprobe with fixed focus 8mm
B dia. x 13 ins long.

B (e) Spare bulb for the light source box BAOD code
B LELP1752.

B (2) Light source box (not in carrying case) BAOD code
B GEEB 0308 for use with the two endoprobes.

B (3) Extractor pt. no. PE17283, BAOD code HMKE 1049
B (used to remove certain intrascope ports).

B (4) Extension lead BAOD code GWAC 1292 (used to take a
B power supply from a/c vacuum cleaner sockets.)

B (5) Probe "Hot Light" quartz iodine 42 inches long BAOD
B Code HZAP 2075.

B C. Inspection

B NOTE: Refer to 72-52-00 page block 601 for LP Turbine
B Assembly Inspection port locations.

B (1) Intrascope inspection of internal engine components.

B (a) Use of equipment

B (a1) HP Turbine Nozzle Guide Vane L/E's (via CCOC outer case) — "Hot Light" Quartz Iodine Probe
B
B
B

B (a2) HP Turbine Nozzle Guide Vane T/E's, HP Turbine blades L/E's & T/E's. — Forward view endoprobe - 8mm dia. x 13" long or lateral view endoprobe 8mm dia. x 19" long.
B
B
B
B
B

B (a3) LP Turbine Nozzle Guide Vanes and blade L/E's. — See Note
B
B

B NOTE 1: Use of either the forward view endoprobe or the lateral view endoprobe solely depends on which probe the operator finds most convenient to use for the various inspections.
B
B
B
B

B NOTE 2: The lateral view endoprobe with focusing can be used in conjunction with the right angle eyepiece if so desired.
B
B
B

B NOTE 3: The LP turbine blade leading and trailing edges are inspected via the jet pipe.
B
B

B D. Power Supplies

B (1) The light source box code GEEB 0308 can be operated on either 240V. AC or 110V. AC. The voltage selector is inside the box. To remove the cover remove the knurled screw on the top of the box and unscrew the two forward screws on the side of the box.
B
B
B
B

B (2) Extension lead code GWAC 1292 can be plugged into the Hoover sockets located near the L/H centre toilet at floor level. This is 110V. AC. Feed the cable out through the forward passenger door to the ground.
B
B
B

END OF THIS SECTION

NEXT

LP TURBINE ASSEMBLY - DESCRIPTION AND OPERATION

1. General

The LP turbine assembly is formed by a ring of nozzles and a turbine rotor with its supporting bearing as shown in the illustration (Ref. Fig. 001).

2. Nozzles

The nozzles are located by flanges in rearward facing grooves in the combustion chamber outer case and are retained by the installed turbine exhaust diffuser assembly. The nozzles are positioned between the HP and LP rotors, the inner portion carrying the seal housings for the HP rotor rear and the LP rotor front labyrinth seals. Two of the nozzle vanes, located at the bottom of the engine, accommodate the turbine cooling air thermocouples.

3. Rotor

The rotor consists of a bladed disk, a front labyrinth and a hub with integral rear labyrinth. Shrouded turbine blades are located in fir-tree form slots, equally disposed around the periphery of the disk, and are retained at the rear face by locking tabs and at the front face by lugs on the blades. When the engine is static, slight clearance exists between the fir-tree form location slots and the blade roots, but because the shrouded blade tips are in peripheral contact the clearance is not apparent. The hub is secured to the LP shaft rear end and the disk, located by Hirth serrations, is bolted to the hub front face. A labyrinth seal is secured to the disk front face while integral lands on the hub rear face form the rear face seal.

4. Bearing

The bearing is located on the rotor hub at the rear of the turbine disk and is housed in the bearing support. A rear cover assembly, enclosed in an insulating blanket and bolted to the rear of the bearing housing, supports the actuating arm and oil feed tube for the LP shaft twist signal system generating mechanism.

The rotor rear labyrinth housing is carried on the front flange of the bearing housing.

5. Operation of the Turbine Assembly

The nozzle and turbine rotor act together to convert a portion of the gas flow energy into shaft power to drive the LP

CR 31356/00A

THERMOCOUPLE

COMBUSTION CHAMBER OUTER CASE

LP TURBINE NOZZLE VANE

LP TURBINE BLADE

LOOKING FORWARD AT TURBINE
COOLING AIR THERMOCOUPLE LOCATIONS

NOZZLE SUPPORT DIAPHRAGM

COOLING HOLES

TURBINE EXHAUST DIFFUSER

HIRTH SERRATIONS

REAR LABYRINTH HOUSING

FRONT LABYRINTH

LP TURBINE HUB AND BEARING

HUB RETAINING NUT

OIL FEED TUBE

HP TURBINE DISK

LP TURBINE DISK

LP COMPRESSOR DRIVE SHAFT

REAR COVER ASSEMBLY INSULATING BLANKET

LP SHAFT SIGNAL SYSTEM GENERATING MECHANISM ACTUATING ARM

CMR 72 52 00 0 AAMO

LP Turbine Assembly
Figure 001

compressor rotor assembly.

When the engine is running, the clearance between the fir-tree form location slots in the disk and the blade roots is taken up.

LOW PRESSURE (LP) TURBINE ASSEMBLY - INSPECTION/CHECK

1. General

The LP turbine rotor blades leading edges are examined without dismantling the engine by the use of an optical inspection probe inserted through one of two sealed ports located in the CCOC rearward of the fuel drains tank. The trailing edges of the turbine rotor blades are accessible from the jet pipe.

The LP turbine nozzle vanes are examined from the same access points as the rotor blades.

A. Read the following information regarding the use of borescope equipment. This outlines how these may affect safety and their classification relative to our Procedures. The precautions listed must be complied with.

(1) Background and Description

Borescope inspections of internal engine components are frequently carried out. These inspections, when conducted with equipment utilising a light source box, now require additional precautions to be taken to eliminate risk of hazard when used in an environment potentially containing combustible gases.

Engines installed or near an aircraft, inside or outside a hangar, fall within the compass of this environment. Uninstalled engines in workshops may also be in a hazardous environment.

These environments are termed "Zone 2" areas but dedicated Zone 2 certification for equipment is not granted by the Regulatory Authority and it is deemed "UNCERTIFIED EQUIPMENT".

A borescope kit comprises of several pieces of equipment but it is only the high intensity light source box which is of concern. Existing boxes (Uncertified Equipment) display a warning notice stating it must not be used in the presence of combustible gases.

Conditions of use of such equipment in a Zone 2 area in strict accordance with procedures (i.e. using gas monitors, etc.) would impose a considerable maintenance/operational burden.

An acceptable relaxation of this situation has been agreed following consultation/borescope demonstration with the Fire Protection Department; although relaxed, adequate safety standards and legal aspects are maintained provided the following precautions are adhered to.

(2) <u>Engines, Installed or near an aircraft</u>

(a) Check aircraft fuel log to ensure it has not uplifted a wide cut fuel (Jet B) during the previous 20 hours of operation.

(b) Aircraft must not be transferring fuel.

(c) Working inside aircraft fuel tanks must not be in progress.

(d) Flammable Liquids with a flash point below 90°F (32°C) must not be used within the Remotely High Risk area - as defined in Section 5.2, EDP-P-FIRE 4.

(e) Spraying or use of Petroleum Based Adhesives must not be permitted.

(f) Liquid Petroleum Gases must not be used within the Remotely High Risk area.

(g) If highly flammable liquids are present and "Uncertified Equipment" needs to be used or if any of the above conditions cannot be met, then Section 5.3 of EDP-P-FIRE 4 must be vigilantly followed.

(h) Where applicable, Bonding must take place.

(3) <u>Engines in Workshops</u>

(a) Conditions (2)(d), (2)(e), (2)(f) and (2)(g) apply.

2. Tools and Equipment

Probe	Part of kit PE.35891	PE.24262
Sleeve (retained on probe)...		S3S.11209000
Light transmitting cable ...		PE.24099
Probe eyepiece...		PE.15969
Light source box		PE.24304

3. Terminology for Damage

A. Apply the following definitions to the terms used to describe damage:

(1) Break. A separation by force into two or more pieces.

(2) Crack. Visible partial separation of material which may progress to a complete break (Ref.(1)).

(3) Distortion. Excessive deformation of the original contour of the part, (associated terms, buckle, depression, twist, warp).

(4) Mis-match. Improper association of two or more parts.

(5) Torn. Separation by pulling apart.

4. Examination of LP Turbine Rotor Blades and Nozzle Vanes (Ref.Fig.601)

A. Prepare Engine for Examination.

(1) Open engine bay rear lower door (Ref.71-00-00, Servicing).

(2) Carry out the safety precautions and work sequences required for access to the jet pipe as detailed in 71-00-00, Servicing.

(3) Install LP rotating assembly hand turning equipment (Ref.72-09-01).

B. Remove Flanged Sealing Bar Assembly.

(1) Remove one of the flanged sealing bars at rear of drains tank position (Ref.Fig.601).

(a) Remove bolts securing cover plate and flanged sealing bar and detach cover plate.

<u>NOTE:</u> There are two configurations of turbine inspection port access at rear of drains tank position (Ref.Fig.601).

(b) Withdraw sealing bar from engine.

(i) On engines to pre S.B. OL.593-72-58 standard, remove any deposits of jointing compound from abutment surfaces (Ref. 70-00-08).

(ii) On engines to S.B. OL.593-72-58 standard, remove gasket.

C. Prepare and Test Optical Inspection Equipment(Ref.72-09-03).

D. Examine Rotor Blades and Nozzle Vanes.

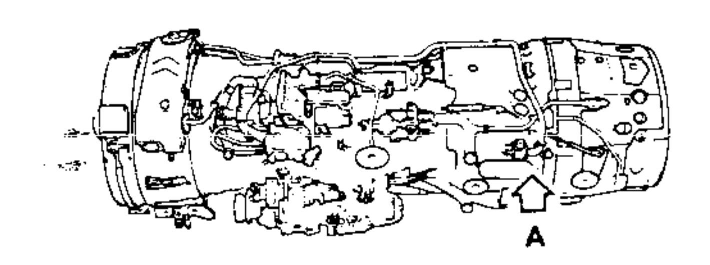
<u>CAUTION:</u> DO NOT MOVE LIGHT SOURCE BOX WHILE SWITCHED ON OR WITHIN 30 SECONDS OF SWITCHING OFF. BULB FILAMENT IS NOT SHOCK RESISTANT WHEN HOT.

(1) Commence examination using probe PE.24262, in conjunction with light source box PE.24304 and cable PE.24099. Turn the engine as necessary to ensure full coverage of all surfaces to be examined. Record extent of any damage or debris found, using the terms given in paragraph 3 and by reference to Figure 602. If a photographic record of the damage is required, use the equipment and procedures detailed in 72-09-04.

<u>CAUTION:</u> RETAIN PROTECTIVE SLEEVE ON PROBE AT ALL TIMES EXCEPT WHEN REMOVAL IS ESSENTIAL FOR INSERTION OF PROBE OR ITS EFFECTIVE USE WHEN INSERTED.

(a) Insert probe and ensure free penetration.

CR 31079/00D



DRAINS TANK

A

A

COMBUSTION CHAMBER OUTER CASE

GASKET (SB 72-58)

FLANGED SEALING BAR

COVER PLATE

COMBUSTION CHAMBER OUTER CASE

BLANKING PLATE

ALTERNATIVE STANDARD

LP Turbine Inspection Ports
Figure 601

R

EFFECTIVITY: ALL

(b) Switch on probe illumination and commence examination

R NOTE: There are 79 LP turbine rotor blades per
R set.

(c) Carefully examine the leading edge region of the turbine rotor blades for damage, signs of blockage or evidence of debris wrapped around the leading edges. Check that each blade shroud middle-loaded abutment face has a bridge piece pad in correct abutment with the pad on the adjacent blade shroud. Change the probe position and vary the depth of insertion as necessary to obtain coverage.

NOTE: If the HP turbine Inspection/Check procedure (Ref.72-51-00) is to be carried out, phase it in with this sequence.

(d) On completion of examination switch off illumination and withdraw probe.

(e) Assess the acceptability of any damage found by comparison of the examination results with the acceptance standard stated in paragraph 5.

(2) Continue examination by obtaining access through the jet pipe. Turn engine as necessary to ensure full coverage of surfaces to be examined. Record extent of any damage found using the terms given in paragraph 3 and by reference to illustration (Ref.Fig.602).

(a) Carry out a visual and tactile examination of the trailing edge region of turbine rotor blades for signs of damage. Also check the blade shrouds for tightness by the application of moderate thumb and finger pressure at the blade trailing edge, inboard of the shroud.

(b) Carry out a visual examination of the turbine nozzle vanes for signs of damage.

(3) Remove hand turning equipment (Ref.72-09-01).

(4) Stow optical inspection equipment (Ref.72-09-03).

(5) Assess the acceptability of any damage found by comparison of the examination results with the acceptance standards stated in paragraphs 5 and 6.

E. Install Flanged Sealing Bar Assembly (Ref.Fig.601).

R CAUTION: IT IS ESSENTIAL THAT LUBRICANT 'C' IS USED
R ON THE APPLICABLE BOLTS/NUTS DURING
R ASSEMBLY (REF. SB.OL.593-72-9044-436).

(1) Apply lubricant C to bolts (Ref. 70-00-01, Servicing and Storage Materials).

(2) On engines to pre S.B.OL.593-72-58 standard, apply jointing compound A (Ref. 70-00-08) to abutment surfaces, insert flanged sealing bar into engine.

(3) On engines to S.B.OL.593-72-58 standard, position a gasket on mounting boss and insert flanged sealing bar into engine.

(4) Position cover plate on sealing bar and secure with two bolts torque-tightened to 100 lbf in (11,5 N.m).

(5) Wire-lock bolts together.

F. Complete the Installation.

(1) Remove servicing equipment installed in the jet pipe for access complying fully with the procedure detailed in 71-00-00, Servicing.

(2) On completion of work, close engine bay doors (Ref. 71-00-00, Servicing).

5. Rotor Blades Acceptance Standards (Ref. Fig.602)

A. Blade Aerofoil Damage.

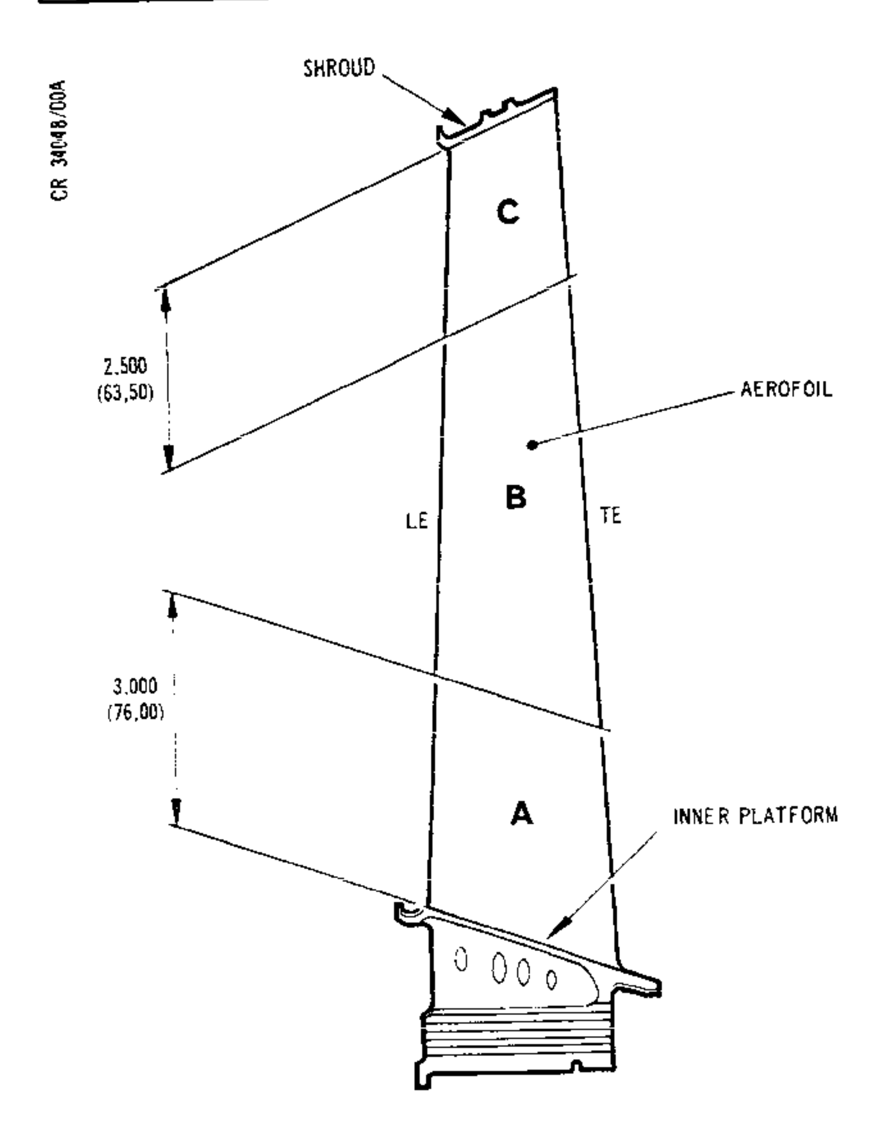
(1) Impact damage which affects not more than five blades, is smoothly contoured, free from cracks and does not penetrate through the aerofoil to any cooling hole, is acceptable provided that:

(a) Zone A

(a1) Damage marks have a diameter not greater than 0.08 in. (2 mm) and,

(a2) Are not deeper than 0.01 in. (0,25 mm).

(a3) Trailing edge deformation does not exceed 0.02 in. (0,5 mm).



CMR 72 52 00 6 BAMO

LP Turbine Rotor Blades - Identification of Zones
Figure 602

(a4) The distance between any two damage marks is not less than 0.75 in. (19 mm).

(b) Zone B

(b1) Damage marks have a diameter not greater than 0.125 in. (3,2 mm) and,

(b2) Are not deeper than 0.015 in. (0,4 mm).

(b3) Trailing edge deformation does not exceed 0.03 in. (0,8 mm).

(b4) The distance between any two damage marks is not less than 0.75 in. (19 mm).

(c) Zone C

(c1) Damage marks have a diameter not greater than 0.2 in. (5 mm) and,

(c2) Are not deeper than 0.02 in. (0,5 mm).

(c3) Trailing edge deformation does not exceed 0.04 in. (1 mm).

(c4) The distance between any two damage marks is not less than 0.25 in. (6,3 mm).

B B B B NOTE: Damage which exceeds that stated in paragraph (1) above, must be referred to Propulsion Engineering so that monitoring requirements may be determined.

(2) Impact damage which exceeds the limits stated in (1), but which affects not more than five blades, is acceptable for a maximum of eight flights only, provided that all the remaining blades, if damaged, are within the acceptable limits stated in (1) and that:

(a) Zone A

(a1) Tears are not longer than 0.02 in. (0,5 mm) and have no cracks running into the undamaged blade material.

(a2) Damage marks have a diameter not greater than 0.125 in. (3,2 mm) and,

(a3) Are not deeper than 0.015 in. (0,4 mm).

(a4) Trailing edge deformation does not exceed 0.03 in. (0,8 mm).

(a5) The distance between any two damage marks is not less than 0.2 in. (5 mm).

(b) Zone B

(b1) Tears are not longer than 0.1 in. (2,5 mm) and have no cracks running into the undamaged blade material.

(b2) Damage marks have a diameter not greater than 0.2 in. (5 mm) and,

(b3) Are not deeper than 0.02 in. (0,5 mm).

(b4) Trailing edge deformation does not exceed 0.04 in. (1 mm).

(b5) The distance between any two damage marks is not less than 0.2 in. (5 mm).

(c) Zone C

(c1) Tears are not longer than 0.2 in. (5 mm) and have no cracks running into the undamaged blade material.

(c2) Damage which penetrates through to No.1 cooling hole, is not deeper than 0.2 in. (5 mm) into the aerofoil from the leading edge, and extends no further than 0.75 in. (19 mm) along the leading edge.

(c3) Isolated heavy impact and damage marks, which penetrate through to cooling holes other than No.1, have a diameter not greater than 0.2 in. (5 mm).

(c4) Damage to the trailing edge, is not deeper than 0.2 in. (5 mm) into the aerofoil and extends no further than 0.75 in. (19 mm) along the trailing edge.

(c5) Trailing edge deformation does not exceed 0.05 in (1,3 mm).

B. Blade Shroud Damage

NOTE: Any blade shroud damage must be referred to Propulsion Engineering so that monitoring requirements may be determined.

(1) Impact damage which is smoothly contoured and free from cracks is acceptable provided that:

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(a) Damage marks have a diameter not greater than 0.2 in. (5 mm) and,

(b) Are not deeper than 0.02 in. (0.5 mm).

(c) Shroud side face and/or shroud trailing edge distortion does not exceed 0.04 in. (1 mm).

(d) When moderate hand pressure is applied, at the blade trailing edges inboard of the shroud, in an attempt to separate the two adjacent blades, no relative movement is detected and the blade shrouds remain tightly in abutment.

(e) If sliding movement between blade abutment faces is detected, but not separation, when blade contact is checked as in paragraph (d), the damage is periodically checked at intervals not exceeding 90 hours of engine flight time.

(f) When one shroud abutment pad is missing:

R (f1) The adjacent blades remain secure and cannot slide along their contact faces or be separated and,

R (f2) The damage is inspected at intervals not exceeding 25 hours of engine flight time.

(g) When two shroud abutment pads are missing:

R (g1) The two damaged blade shrouds are separated by at least 10 undamaged blade shrouds and,

R (g2) The blades adjacent to the damaged shrouds remain secure and cannot slide along their contact faces or be separated and,

R (g3) The damage is inspected at intervals not exceeding 25 hours of engine flight time.

(h) When three shroud abutment pads are missing:

R (h1) Two of the damaged blade shrouds are separated by at least 10 undamaged blade shrouds and the third damaged shroud is separated from the other two by at least 25 undamaged shrouds and,

R (h2) The blades adjacent to the damaged shrouds remain secure and cannot slide along their

contact faces or be separated and,

R (h3) The damage is inspected at intervals not exceeding 25 hours of engine flight time.

(j) Cracks from bridge piece pad, short braze face:

R (j1) Extend no further than 0.06 in. (1,5 mm) into blade shroud parent material on underneath of shroud and,

R (j2) The cracks are periodically checked at intervals not exceeding 90 hours of engine flight time and,

R (j3) The shroud abutment faces remain tightly in contact and no single abutment face can be separated from the adjacent blade.

(k) Mis-match between extreme edge of shroud abutment pad and shroud notch on adjacent blade (Ref. Fig. 603):

R (k1) Does not exceed 0.075 in. (1,9 mm) and,

R (k2) The shroud abutment faces remain tightly in contact and no single abutment face can be separated from the adjacent blade and,

R (k3) The damage is periodically checked at intervals not exceeding 90 hours of engine flight time.

<u>NOTE</u>: When any damage monitoring checks are necessary, access to the trailing edges of the blades can be gained through the jet pipe.

(2) Heavy impact damage on the shroud is acceptanle for a maximum of eight flights only, provided that:

(a) Not more than one abutment face pad is missing.

(b) No two adjacent blades are separable by any amount.

(3) Shrouds which are damaged within the acceptable limits stated in paragraph (1) but on which manual separation of the blades is possible, are acceptable for a maximum of eight flights only, provided that:

(a) No blade shroud abutment face can be separated from the adjacent shroud abutment face by more than 0.01 in. (0,25 mm).

(4) Mis-match which exceeds 0.075 in. (1,9 mm) between the extreme edge of the shroud abutment pad and the shroud notch on the adjacent blade (Ref. Fig.603) is acceptable for a maximum of eight flights only, provided that:

(a) The mis-match is not greater than 0.125 in. (3,2 mm) and,

(b) If contact between the shroud abutment faces has eased, the gap is not greater than 0.01 in. (0,25 mm).

(5) The loss of up to a maximum of three shroud abutment pads, which makes manual separation of the blades possible, is acceptable for a maximum of eight flights only, provided that:

(a) No blade shroud contact face can be separated from the adjacent shroud contact face by more than 0.01 in. (0,25 mm).

(b) When two shroud abutment pads are missing, there are at least ten undamaged shrouds between them.

(c) When three shroud abutment pads are missing, two of the damaged shrouds are separated by at least 10 undamaged shrouds and the third damaged shroud is separated from the other two by at least 25 undamaged shrouds.

R 6. <u>Nozzle Vanes Acceptance Standards</u> (Ref.Fig.604)

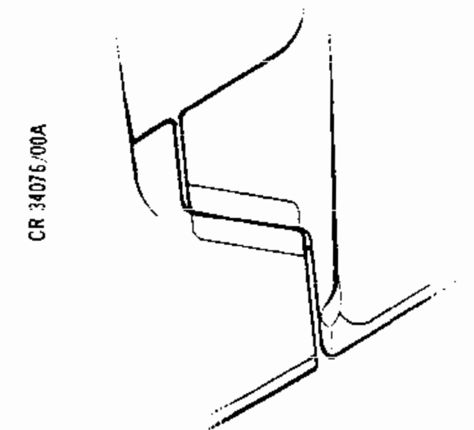
A. Vane Aerofoil Damage.

(1) The following damage is acceptable on any number of vanes.

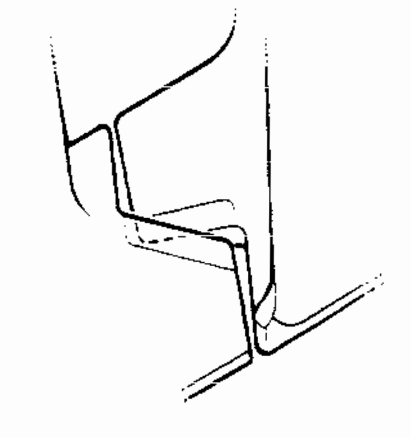
(a) Chipping of pack aluminising.

(b) Areas of erosion/corrosion (with or without cracks defined in paragraphs (c), (d) and (e)) over the entire vane surface.

(c) Multiple cracking of vane leading edge (often short, closely spaced and hairline in appearance and associated with erosion/corrosion) - any



BEFORE SHROUD DISTORTION



MIS-MATCH AFTER SHROUD DISTORTION

SHROUD NOTCH

LP TURBINE BLADE

BLADE SHROUD

MIS-MATCH MEASURING POINTS

SHROUD ABUTMENT PAD

CMR 72 52 00 6 CAM0

Blade Shroud Abutment Pad/Notch Mis-Match
Figure 603

number of cracks up to 0.5 in. (12,7 mm) long.

R (d) Single crack not more than 2.0 in. (51 mm) long extending from the trailing edge of the vane.

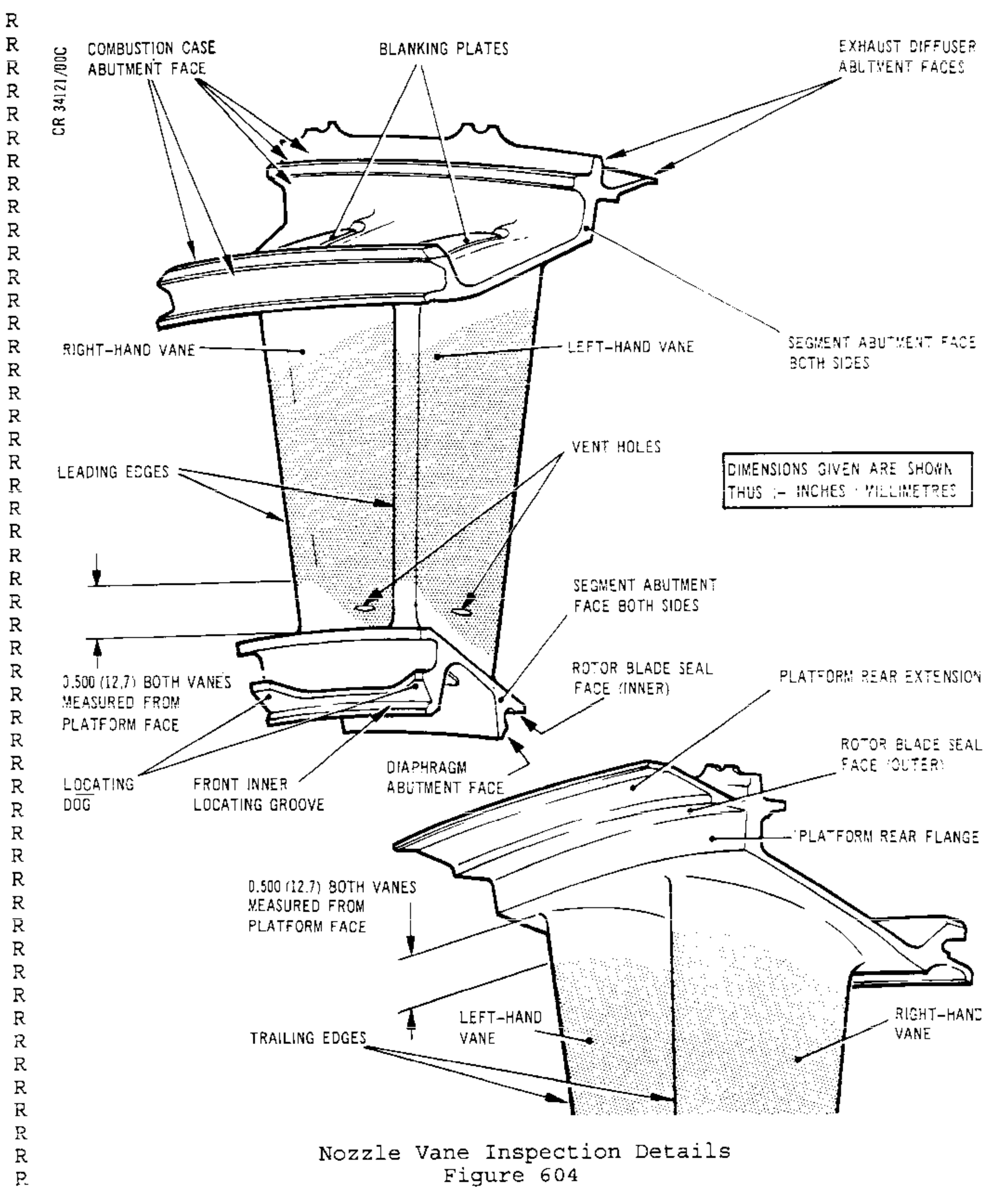
R (e) Impact damage.

R (e1) Material up to 3.0 sq.in. (580 sq.mm) removed by impact on the vane trailing edge.

R (e2) Cracks emanating from damage or deformation provided they are within the limits of paragraph (d).

R (e3) Puncturing of vane material up to 0.5 in. (12,7 mm) diameter with or without corrosion but with no evidence of burning.

R (e4) Displacement or deformation of vane trailing edges up to 0.1 in. (2,5 mm) provided that it does not exceed 1.0 in. (25 mm) in length.



Nozzle Vane Inspection Details
Figure 604

TURBINE EXHAUST DIFFUSER ASSEMBLY - DESCRIPTION AND OPERATION

1. Description (Ref. Fig.001 and 002)

The turbine exhaust diffuser is secured to the rear of the combustion chamber outer case and the front of the spherical flange adapter by bolted flanges. The inner cone and outer case are joined by hollow vanes to form one unit. The vanes are integral with the inner cone and are secured to the outer case with dowels, bolts and trunnion nuts.

The inner cone supports the LP turbine bearing housing and, on its rear flange, the jet pipe thermocouple assembly with the thermocouples protruding into the annulus of the diffuser assembly. The reheat injection system is mounted on the jet pipe thermocouple assembly by means of rods that locate the spray ring centrally in the reheat chamber.

The hollow vanes of the assembly provide passageways for bearing pressurizing air, ventilating air and oil feed and scavenge tubes. The outer case supports the LP turbine containment shield and the heat shield.

2. Operation

The gas flow from the LP turbine assembly enters the exhaust diffuser where it is straightened by the vanes to flow axially into the exhaust system.

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COMBUSTION CHAMBER OUTER CASE

BLADE CONTAINMENT SHIELD

HEAT INSULATION SHIELD

EXHAUST DIFFUSER OUTER CASE

SPHERICAL JOINT FLANGE

REHEAT INJECTION SYSTEM

CMR 72 53 00 0 AAMO

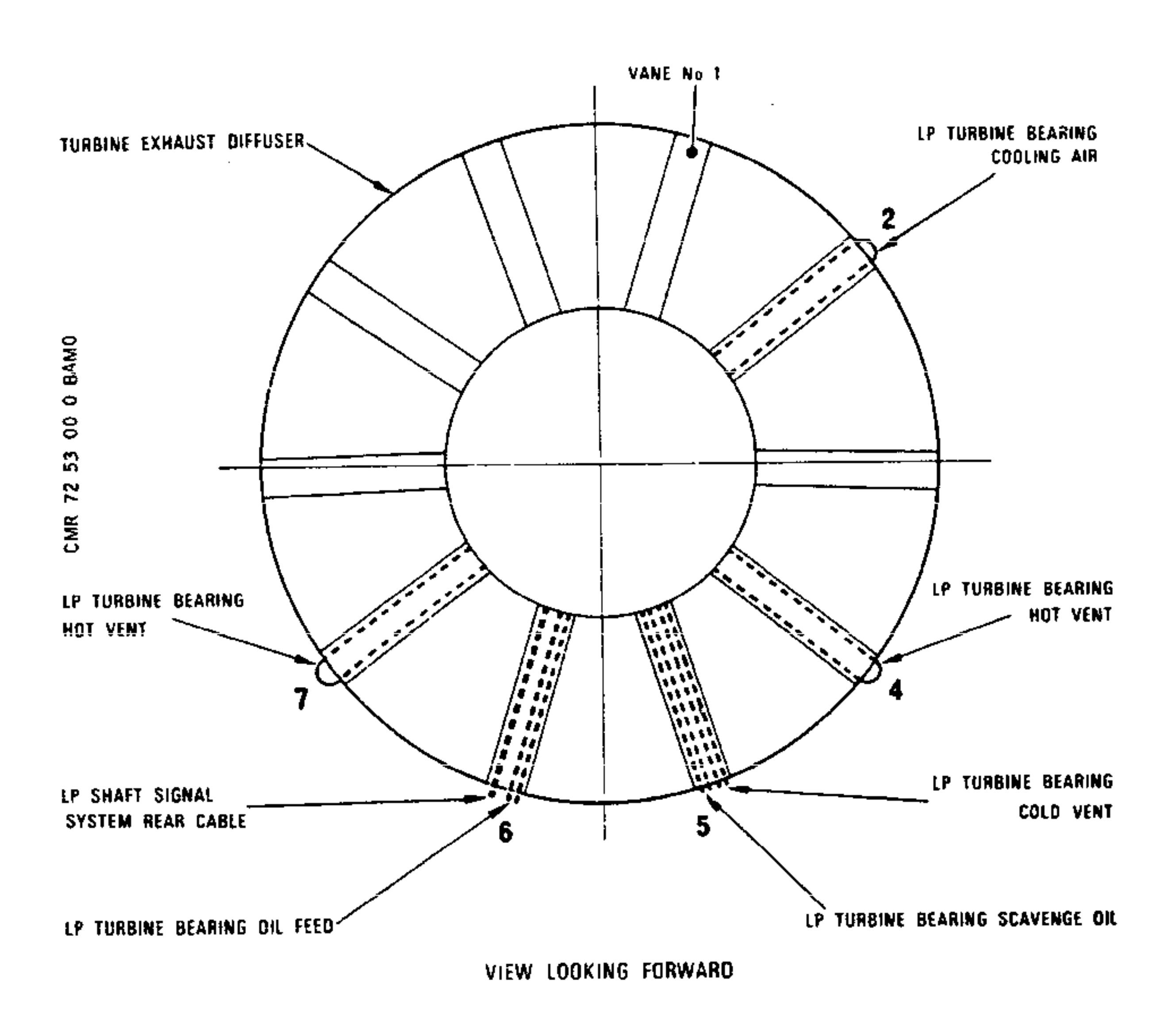
INNER CONE

JET PIPE THERMOCOUPLE ASSEMBLY

TRUNNION NUT

Turbine Exhaust Diffuser
Figure 001

CR 31348/00A



Exhaust Diffuser Vane Services
Figure 002

TURBINE EXHAUST DIFFUSER ASSEMBLY - INSPECTION/CHECK

1. General

This chapter states the acceptable limits of damage to the turbine exhaust diffuser. Access to the diffuser is obtained through the jet pipe.

Paragraph 4 details acceptance standards in respect of exhaust diffuser vanes and is sub-divided to define limits of damage that are acceptable for continued service (4.A.) and extended limits that are acceptable within a maximum limit of a further 25 hours flying (4.B.). Unacceptable vane damage is defined in paragraph 4.C.

Paragraphs 5 to 7 detail acceptance standards for other regions of the diffuser. For details of acceptance standards for turbine exhaust diffuser heat shields, refer to 71-32-02, Inspection/Check.

Details of damage monitoring checks are given in paragraph 8.

2. Terminology for Damage

A. Apply the following definitions to the terms used to describe damage:

(1) Broken. Separated by force into two or more pieces.

(2) Buckled. See (8) Distorted.

(3) Burned. Destructive oxidation usually caused by higher temperature than the parent material can withstand.

(4) Collapsed. Inward deformation of the original contour of a part. Usually caused by high pressure differentials such as a collapsed bellows.

(5) Cracked. Visible partial separation of material which may progress to a complete break (Ref. (1) Broken).

(6) Dented. An indentation usually caused by impact of a foreign object. Parent material is displaced, seldom separated.

(7) Deposits. A build-up of material on a part either from foreign material or from another part not in direct contact.

(8) Distorted. Extensive deformation of the original contour of a part usually due to impact of a foreign object, structural stresses, excessive localized heating or any combination of these.

(9) Fractured. See (1) Broken.

(10) Fretted. See (11) Galled.

(11) Galled. Chafing or severe fretting caused by slight relative movement of two metal surfaces under high contact pressure.

(12) Gouged. Scooping out of material. Usually caused by a foreign object.

(13) Obstructed. See (16) Plugged.

(14) Overheated. Subjected to excessive temperature usually evidenced by change in colour and appearance of part.

(15) Pierced. The puncturing of a material.

(16) Plugged. Pipe, hoses, tubing, channelling, internal passage, etc., which are totally or partially blocked.

(17) Rubbed. To move with pressure or friction against another part - such as compressor rub.

(18) Torn. Separation by pulling apart.

3. Examination of Turbine Exhaust Diffuser (Ref. Fig. 601)

A. Prepare Engine for Examination.

(1) Carry out the safety precautions and work sequences required for access to the jet pipe as detailed in 71-00-00, Servicing.

B. Examine Turbine Exhaust Diffuser.

(1) Observe the safety precautions detailed in 71-00-00, Servicing, and enter the jet pipe. Commence the examination of the exhaust diffuser in a good light and record the extent of any damage found, using the terms given in paragraph 2 and by reference to the illustration.

(a) Carry out a visual and tactile examination of

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COMBUSTION CHAMBER OUTER CASE

BLADE CONTAINMENT SHIELD

HEAT INSULATION SHIELD

EXHAUST DIFFUSER OUTER CASE

SPHERICAL JOINT FLANGE

REHEAT INJECTION SYSTEM

INNER CONE

JET PIPE THERMOCOUPLE ASSEMBLY

TRUNNION NUT

CMR 72 53 00 6 AAM0

Turbine Exhaust Diffuser - Identification of Parts
Figure 601

the vanes for cracks, impact damage, overheating and other damage.

(b) Inspect the exhaust diffuser outer case for cracks, dents, gouges, impact damage and metallic deposits.

(c) Check the vanes to outer case attachment bolts for fracture.

NOTE: Movement of the trunnion nut in its location, when finger pressure is applied, can indicate fracture of the outer case attachment bolt.

(d) Examine the exhaust diffuser inner cone for cracks.

(2) If damage is found, the cause of which could have been defects upstream of the exhaust diffuser, carry out the combustion chamber Inspection/Check (Ref. 72-41-01) and turbine Inspection/Check (Ref.72-51-00).

(3) Assess the acceptability of any damage found by comparison of the examination results with the acceptance standards stated in paragraphs 4 to 7.

(4) Remove servicing equipment installed in the jet pipe for access and comply fully with the procedure detailed in 71-00-00, Servicing.

4. Acceptance Standards - Vanes (Ref. Fig. 602)

R B NOTE: Any significant damage to the Turbine exhaust
R B diffuser must be referred to Power Unit Engineering
R B so that monitoring requirements may be determined
R B and called up by E.I

A. Acceptable Limits of Damage for Continuation in Service.

(1) Cracks in the leading edge (Ref. Fig. 603) provided that :

(a) There is not more than one crack in each vane in this area and,

(b) Not more than three vanes are affected and,

(c) The total length of a crack does not exceed 5 in. (127 mm) on vanes numbered 1, 3, 8, 9 and 10 or,

(d) The total length of a crack does not exceed 3 in. (76 mm) on vanes numbered 2, 4, 5, 6 and 7.

NOTE: Vanes numbered 2, 4, 5, 6 and 7 carry the various engine services (Ref. Fig. 602).

(e) The crack does not divide into branches.

(f) The cracks are periodically checked at intervals not greater than 90 hours of engine flight time.

(2) Cracks around the inner cone fillet radii on the vane leading or trailing edge (Ref. Fig. 604) provided that:

(a) There is not more than one crack in either the leading edge or the trailing edge in each vane in this region, the total length of any single crack is not greater than 3 in. (76 mm) and does not propagate more than l in. (25,4 mm) into the inner cone and,

(b) The crack does not divide into branches and,

(c) Not more than three vanes are affected and,

(d) The cracks are periodically checked at intervals not greater than 165 hours of engine flight time.

(3) Cracks in the cast vane end (Ref. Fig. 605) provided that:

(a) There is not more than one crack in each vane end and,

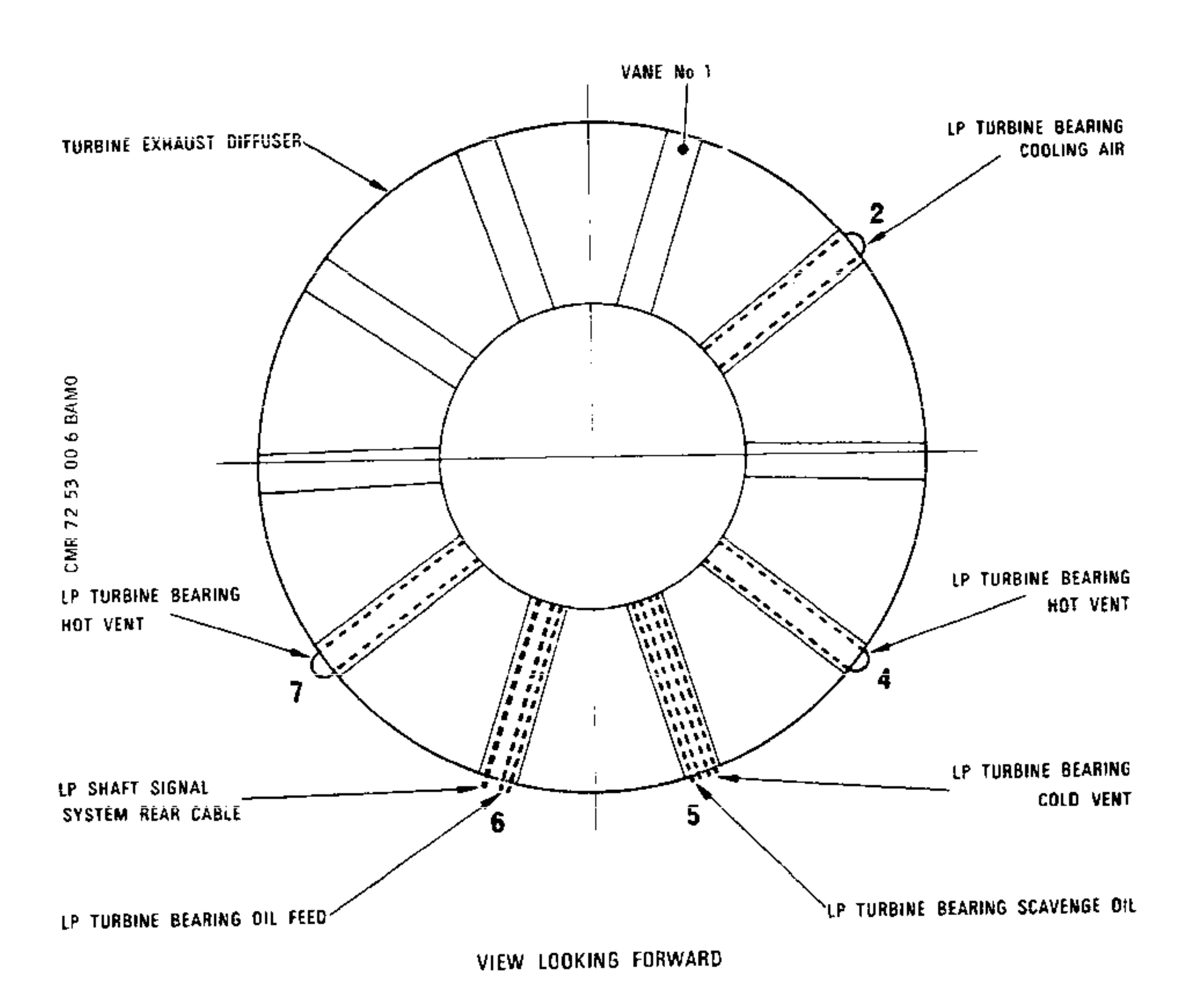
(b) Not more than three vanes are affected and,

(c) No single crack is longer than 1.5 in. (38 mm) and,,

(d) The crack does not divide into branches or run into the vane end/vane weld.

(e) Single cracks which run into the vane trunnion nut location at the leading edge positions do not affect more than two vanes.

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CMR 72 53 00 6 BAMO

Exhaust Diffuser Vane Services
Figure 602

CR 31683/00A

VANE

CRACK DIVIDED

MATERIAL LOSS

TOTAL LENGTH OF
CRACK APPLIES

LEADING EDGE

TRAILING EDGE

CMR 72 53 00 6 CAMO

Example of Vane Leading Edge Crack
Figure 603

CR 31685/00A

MATERIAL LOSS
WELD
TRAILING EDGE CRACK
CRACK DIVIDES AND RUNS INTO WELD
TRAILING EDGE
VANE
LEADING EDGE CRACK
TOTAL LENGTH OF CRACK APPLIES
LEADING EDGE

CMR 72 53 00 6 DAMO

Examples of Vane Inner Cone Fillet
Radii Cracks
Figure 604

CR 31686/00A

TRUNNION NUT LOCATION HOLE

CRACK

VANE END/VANE WELD

VANE

LEADING EDGE

TRAILING EDGE

CMR 72 53 00 6 EAM0

Examples of Cracks in Cast Vane End
Figure 605

(f) The cracks are periodically checked at intervals not greater than 90 hours of engine flight time.

(4) Overheated vanes provided that:

(a) There is not more than one area of overheating on each vane and,

(b) The damage is periodically checked at intervals not greater than 90 hours of engine flight time.

(5) Leading edge buckled and/or vane collapsed on vanes numbered 1, 3, 8, 9 and 10 (Ref. Fig. 606) provided that:

NOTE: Buckled leading edges and/or collapsed vanes are usually associated with overheating.

(a) There is not more than one buckled area on the leading edge of each vane and,

(b) The leading edge distortion does not have a lateral displacement greater than 0.5 in. (12,7 mm).

(6) Leading edge buckled on vanes numbered 2, 4, 5, 6 and 7 provided that:

(a) The leading edge distortion does not have a lateral displacement greater than 0.5 in. (12,7 mm) and,

(b) The damage is periodically checked at intervals not greater than 90 hours of engine flight time.

(7) Impact damage which results in:

(a) Metallic deposits on any vane.

(b) Dents on vanes numbered 1, 3, 8, 9 and 10 provided that:

(b1) They are smooth and are not deeper than 0.125 in. (3,2 mm).

(c) Dents on vanes numbered 2, 4, 5, 6 and 7 provided that:

(c1) They are smooth, not deeper than 0.125 in. (3,2 mm) and are not within area A

CR 31687/00A

TRAILING EDGE

LEADING EDGE

VANE COLLAPSE

BUCKLED LEADING EDGE

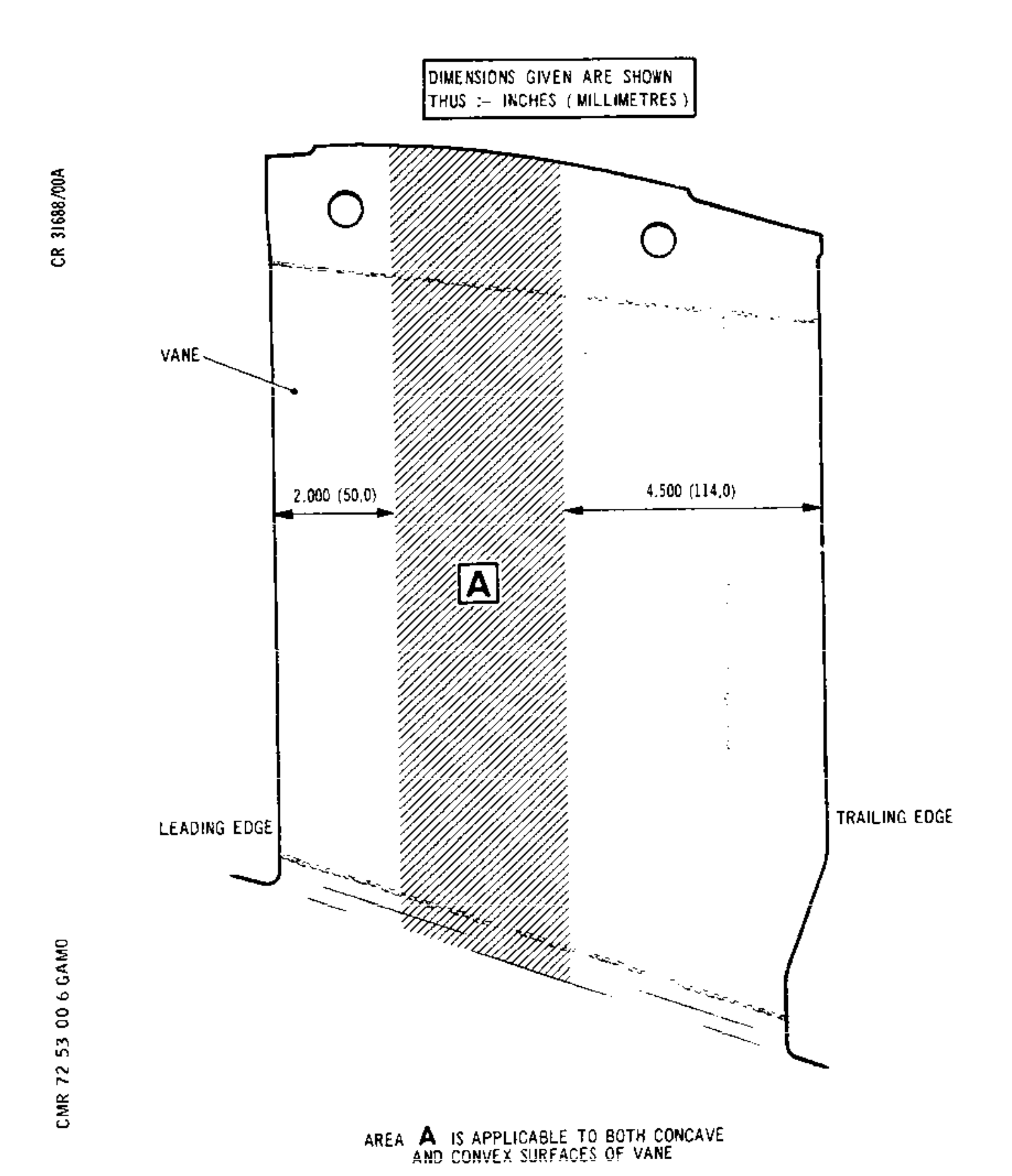
LATERAL DISPLACEMENT

VANE

SECTION SHOWING VANE COLLAPSE

CMR 72 53 00 6 FAM0

Example of Buckled Vane Leading Edge
and Vane Collapse
Figure 606



Prohibited Damage Zone on Service Carrying
Vane
Figure 607

(Ref. Fig. 607).

(d) Gouges on any vane provided that:

(d1) Their greatest dimension does not exceed 0.75 in. (19 mm) and,

(d2) They are not deeper than 0.01 in. (0,25 mm) and,

(d3) There are not more than three gouges on any single vane.

(8) Impact damage which results in a pierced vane skin provided that:

(a) One vanes numbered 2, 4, 5, 6 and 7, no holes are within area A (Ref. Fig. 607) and,

(b) The total hole area on any vane does not exceed 0.2 sq.in. (129 sq. cm) or

(c) On any vane, the greatest dimension of any hole does not exceed 0.25 in. (6,3 mm) and,

(d) There are not more than three holes in each vane, the holes are not less than 1 in. (25 mm) apart and not less than 1 in. (25 mm) from any other damage, and not more than threee vanes are affected and,

(e) The damage is periodically checked at intervals not exceeding 165 hours of engine flight time.

R B NOTE: Any significant damage to the turbine exhaust
R B diffuser must be referred to Power Unit
R B Engineering so that monitoring requirements
R B may be determined and called up by E.I.

B. Extended Limits ; Acceptable for a Maximum of a Further 25 Hours Flying.

(1) Any number of unbranched cracks or one branched crack in the vane leading edge (Ref. Fig. 603) is acceptable provided that:

(a) Cracks are more than 1 in. (25,4 mm) apart.

(b) Not more than three vanes are affected.

(c) The total length of cracks in any vane numbered

CR 31684/00A

VANE

RADIAL CRACKS

LEADING EDGE

MATERIAL LOSS

TRAILING EDGE

CMR 72 53 00 6 HAMO

Examples of Vane Mid-Section Cracks
Figure 608

1, 3, 8, 9 and 10 (Ref. Fig. 602) does not exceed 8 in. (203,2 mm).

(d) The total length of cracks in any vane numbered 2, 4, 5, 6 and 7 (Ref. Fig. 602) does not exceed 6 in. (152 mm).

(e) A branched crack has a total length within the limits of (c) and (d) when crack length is assessed by adding the length of each branch and the originating crack.

(2) Cracks around the inner cone fillet radii or vane leading or trailing edge (Ref. Fig. 604) are acceptable provided that:

(a) There is not more than one crack in either the leading edge or the trailing edge in each vane in this region.

(b) Not more than three vanes are affected.

(c) The total length of each crack is not more than 6 in. (152 mm) and does not propagate more than 3 in. (76 mm) into the inner cone.

(d) Where a crack divides into branches or propagates into the inner cone/vane weld, the length of each branch plus the length of the original crack do not exceed 6 in. (152 mm).

(3) Cracks in the cast vane end (Ref. Fig. 605) are acceptable provided that:

(a) There is not more than one crack in each vane.

(b) Not more than three vanes are affected.

(c) The total length of a crack is not more than 2.5 in. (63,5 mm).

(d) Where a crack divides into branches or runs into a vane weld, the length of each branch plus the length of the original crack do not exceed 2.5 in. (63,5 mm).

(4) Buckling of leading edge and/or vane collapse (Ref. Fig. 606) is acceptable provided that:

(a) There is not more than one buckled area on the leading edge of each vane.

(b) Distortion does not have a lateral displacement greater than 0.75 in. (19 mm).

(5) Any cracks in the concave surface of vane mid section (Ref. Fig. 608) are acceptable provided that:

(a) No more than three vanes are affected.

(b) Cracks do not extend into the leading edge, trailing edge or vane end weld (inner or outer).

(6) Impact damage on vanes is acceptable as follows:

(a) Smooth dents not deeper than 0.5 in. (12,7 mm).

(b) Gouges not more than 1.5 in. (38 mm) long on any vane, provided vane is not pierced.

(c) Holes in vanes 2, 4, 5, 6 and 7 within area A (Ref. Fig. 607) provided that:

(c1) There are not more than three holes in any vane.

(c2) The total hole area does not exceed 0.2 sq. in. (129 sq. mm), or,

(c3) The greatest dimension of any hole does not exceed 0.25 in. (6,3 mm).

C. Unacceptable Vane Damage

(1) Reject exhaust diffuser case with following damage to vanes.

(a) Damage which fails to meet the acceptable limits stated in paragraph 4.

(b) Loss of material anywhere on a vane or on the inner cone fillet radii.

(c) More than one crack in any single vane leading edge between the fillet radiu and the cast vane end.

(d) Cracks in the cast vane end (Ref. Fig. 605) which:

(d1) Run into the trailing edge nut trunnion locations.

(e) Holes(s) burnt into any vane.

(f) Impact damage which results in cracks that exceed the limits stated in paragraph 4.

5. Outer Case Damage

R B NOTE: Any significant damage to the turbine exhaust
R B diffuser must be referred to Power Unit
R B Engineering so that monitoring may be determined
R B and called up by E.I.

A. Acceptable Damage.

(1) The following damage to outer case is acceptable for continuation in service:

(a) Impact damage with metallic deposits on outer case.

(b) Dents, provided that:

(b1) They are smooth and are not deeper than 0.125 in. (3,2 mm).

(c) Gouges, provided that:

(c1) They are not deeper than).02 in. (0,5 mm) at any point.

(2) Damage within the following extended limits is acceptable for a further 25 hours flight time:

(a) Smooth dents not deeper than 0.25 in. (6,35 mm).

(b) Gouges not deeper than 0.040 in. (1,02 mm).

B. Unacceptable Damage.

(1) Reject an exhaust diffuser case with the following unacceptable damage to the outer case:

(a) Damage which fails to meet the acceptable limits stated in paragraph A.

(b) Circumferential and/or axial cracks.

NOTE: Cracks in the diffuser outer case can result in the escape of high temperature gases into the engine bay and possible engine bay overheat.

(c) Pierced outer case.

6. Vane to Outer Case Attachment Bolts

R B NOTE: Any significant damage to the turbine exhaust
R B diffuser must be referred to Power Unit
R B Engineering so that monitoring requirements may
R B be determined and called up by E.I.

A. Acceptable Damage.

(1) The following damage to vane attachment bolts is acceptable for continuation in service:
(a) Fractured bolt at the leading edge position of the vane, provided that:

(a1) Not more than two vanes are affected and,

(a2) The damage is periodically checked at intervals not exceeding 90 hours of engine flight time.

(2) The following damage and extended limit is acceptable for a further 25 hours maximum flight time:

(a) Fractured bolt at leading edge position of three vanes.

B. Unacceptable Damage.

(1) Reject an exhaust diffuser case with the following unacceptable damage to the vane attachment bolts:

(a) Fractured bolt at the trailing edge position of the vane.

7. Inner Cone Damage

A. Unacceptable Damage.

(1) Reject an exhaust diffuser case with the following unacceptable damage to the inner cone:

(a) Circumferential and/or axial cracks.

NOTE: Cracks in the inner cone can result in a rub between the inner cone and the rear of the LP turbine disk.

(b) Loss of material anywhere.

8. Damage Monitoring Checks

A. If damage to the turbine exhaust diffuser is found, within the acceptable limits stated in paragraphs 4 to 8, the affected area must be inspected at the intervals specified. This inspection must also cover the possibility of secondary damage to other areas as follows:

(1) Exhaust diffuser vane damage monitoring checks.

(a) When monitoring cracked vanes, check for signs of secondary damage to the jet pipe thermocouple harness assembly, the reheat injection system and, if the vane is a service carrying vane, possible fracture/obstruction of the service tubes. In addition check downstream of the exhaust diffuser for signs of damage to the spherical joint flange, reheat igniter, engine power pitots, reheat flame detector, primary nozzle control signal pitot and the exhaust assembly. If damage is found, refer to the applicable acceptance standards for the item and/or renew the item.

NOTE: Signs of oil leakage in the exhaust diffuser indicate possible damage to the bearing oil feed and/or return tubes which could lead to failure of the LP turbine bearing.

(b) When monitoring overheated vane damage, in addition to the checks stated in (a), carry out the combustion chamber Inspection/Check (Ref. 72-41-01) and the turbine Inspection/Check (Ref. 72-51-00 and 72-52-00).

NOTE: Buckled leading edges and/or collapsed vanes are usually associated with overheating. Possible secondary damage on service carrying vanes can be fretting between the tube and the vane and may result in tube fracture.

(c) When monitoring impact damage to the vanes, look for outward signs of fracture of the service tubes, e.g. oil leaks, on the service carrying vanes.

(2) Exhaust diffuser vane to outer case attachment bolts damage monitoring checks.

(a) When monitoring fractured attachment bolts, carry out a visual inspection of the remaining bolts for possible fracture.

NOTE: Fractured attachment bolts can lead to fracture/obstruction of the service tubes on the service carrying vanes and, if all attachment bolts fail, could result in loss of the LP turbine bearing support.

R SPHERICAL JOINT FLANGE - DESCRIPTION AND OPERATION

1. General

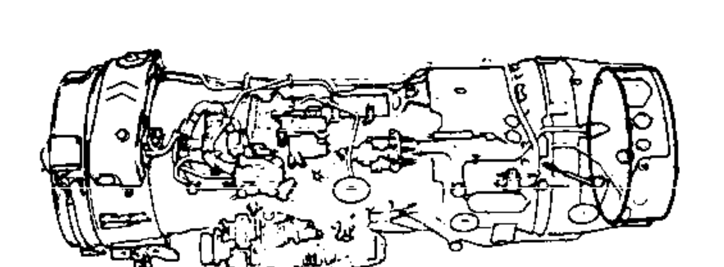
The spherical joint flange is located between the exhaust diffuser and the reheat chamber assembly.

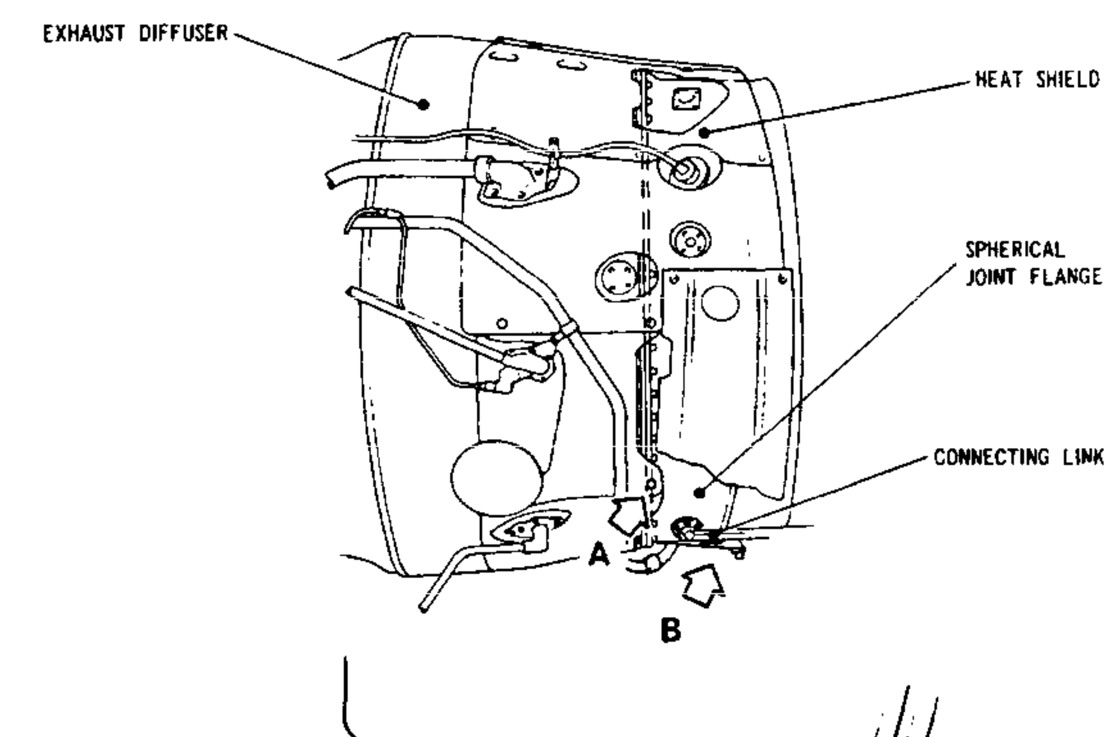
2. Description (Ref. Fig. 001)

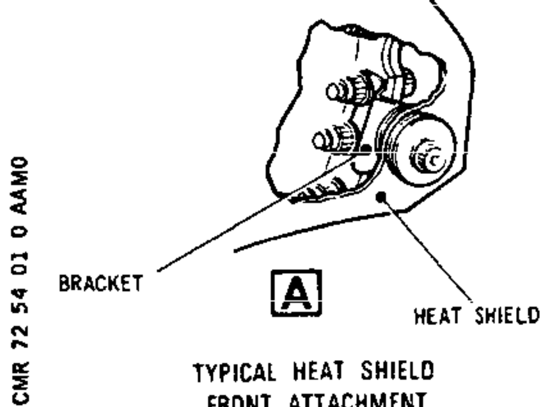
The spherical joint flange is bolted to the rear flange of the exhaust diffuser and is joined to the reheat chamber by a connecting link. Some of the bolts securing the spherical flange to the exhaust diffuser joint also retain brackets while mountings, positioned on the periphery of the assembly, provide for the attachment of engine and airframe service components.

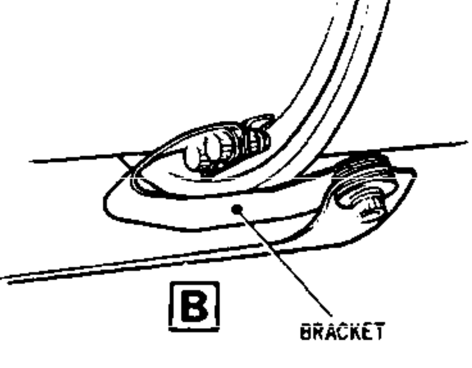
Heat shields are bracket mounted to the joint flange and extend over the outer surface of the assembly. These are described in 71-30-00.

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Spherical Joint Flange
Figure 001

SPHERICAL JOINT FLANGE - REMOVAL/INSTALLATION

1. General (Ref. Fig. 401)

Removal and installation procedures for the spherical joint flange and the spherical joint flange seal cover are given in paragraphs 2 and 3 respectively.

If the same spherical joint flange is to be installed, the removal of attachments stated in paragraph 2.B. is not required unless it is necessary to facilitate other work.

Details of lubricants quoted in this chapter are given in 70-00-01, Servicing and Storage Materials.

2. Spherical Joint Flange - Removal/Installation

A. Remove Spherical Joint Flange.

WARNING: WASH HANDS AFTER CONTACT WITH LUBRICANT G ON HEAT SHIELD PANELS. LUBRICANT CONTAINS COPPER AND LEAD AND IS TOXIC.

(1) Observe the safety precautions and remove the engine from the aircraft (Ref. 71-00-12, Removal/Installation).

(2) Remove the two independently mounted heat shield panels from the side and bottom positions of the spherical joint flange (Ref. 71-32-02, Removal/Installation).

(3) Remove the reheat injection system (Ref. 73-12-06, Removal/Installation) (Ref. Fig. 402).

(4) Remove jet pipe thermocouple lead (Ref. 77-21-03, Removal/Installation).

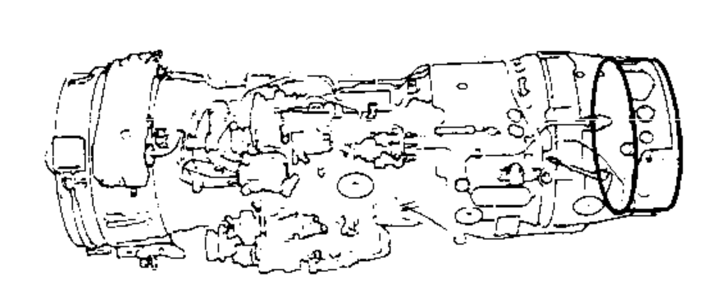
(5) Remove the section of purging air tube between the spherical joint flange and the union connection.

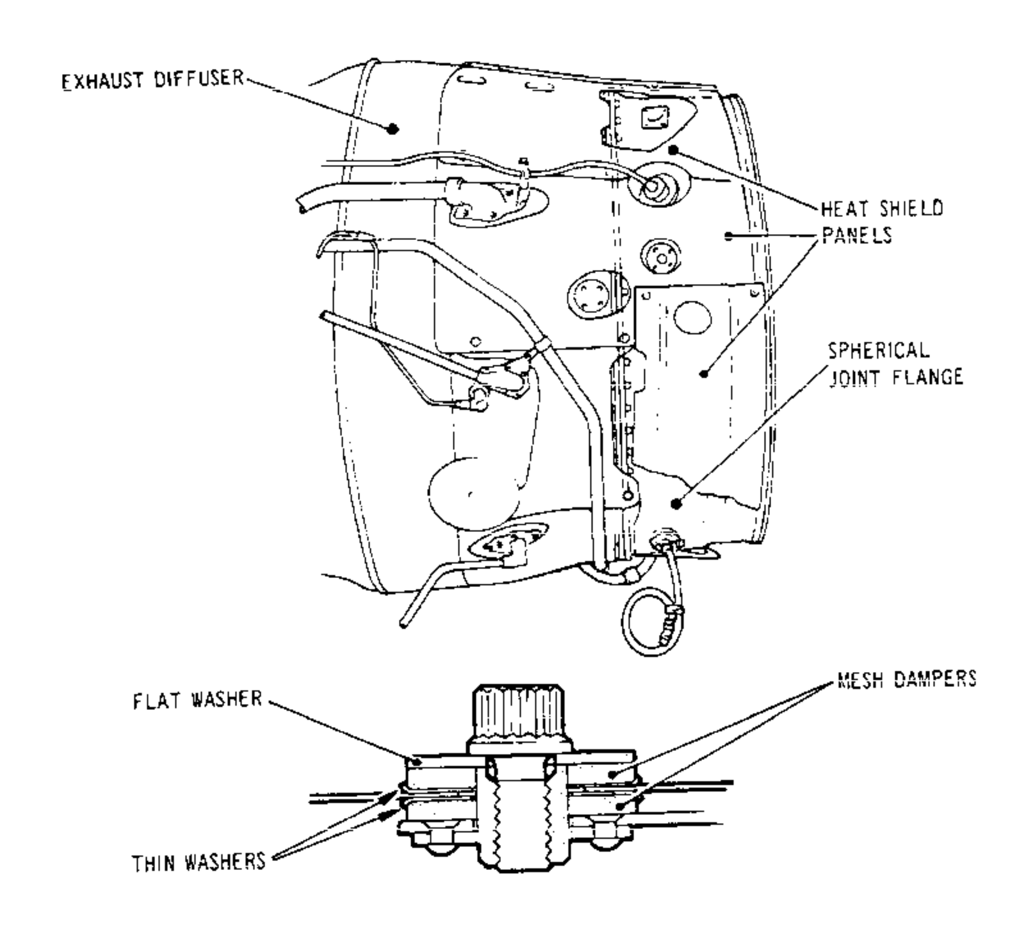
(a) Detach tube supporting clamp assemblies.

(b) Unscrew union nut at union connection and connection at flanged connection on spherical joint flange, then remove tube from engine.

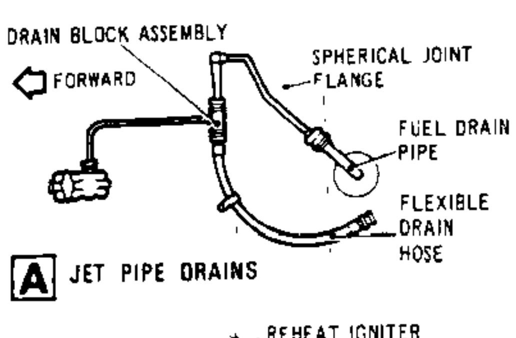
(6) Remove reheat flame detector from spherical joint flange (Ref. Fig. 402).

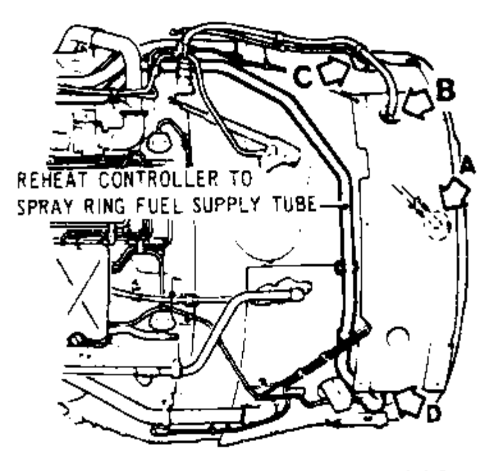
R CAUTION: DO NOT BEND REHEAT FLAME DETECTOR

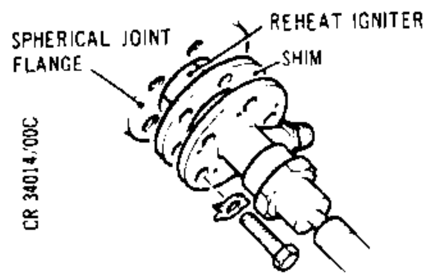


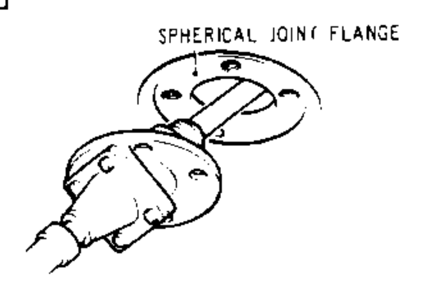


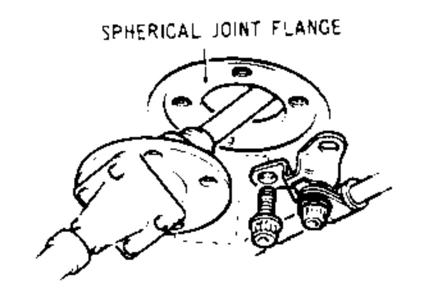
Spherical Joint Flange and Heat Shields - Location
Figure 401

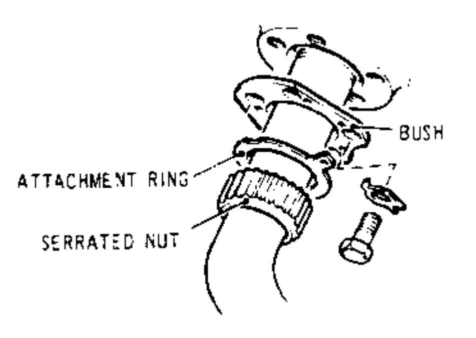


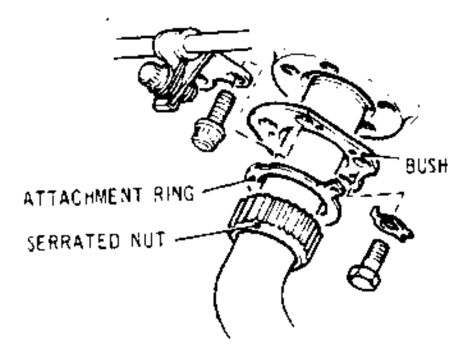












Items to be Detached for Spherical Joint Flange Removal
Figure 402

R

CONDUCTOR AT ANY TIME. BENDING COULD RESULT IN DETERIORATION OF CONDUCTOR INSULATION.

(a) Detach flame detector conductor supporting clamp assembly.

(b) On engines to pre S.B. OL.593-77-10 and 77-11 standard, support flame detector, remove the four securing bolts and withdraw detector from spherical joint flange. Secure clear of work area.

(c) On engines to S.B. OL.593-77-10 and 77-11 standard, slacken pitot tube clamp assembly bolt, support flame detector, then remove four securing bolts. Move pitot tube and clamp assembly with attached bracket clear of flange and withdraw detector from spherical joint flange. Secure detector clear of work area.

(7) Remove jet pipe drains tube section and flexible drain hose clamp (Ref.Fig.402).

(a) Unscrew union nut at fuel drain pipe connection on spherical joint flange and union nut at drain block assembly, then remove tube section from engine.

(b) Remove the clamp which secures the flexible drain hose to the bottom of the spherical joint flange.

R (8) Paragraph deleted.

(9) Remove/detach the ten heat shield panels.

WARNING: WASH HANDS AFTER CONTACT WITH LUBRICANT G ON HEAT SHIELD PANELS. LUBRICANT CONTAINS COPPER AND LEAD AND IS TOXIC.

NOTE: The heat shields may be removed in any order, but removal in sequence is recommended.

(a) Remove the two rows of bolts, flat washers, dampers and thin washers which secure a heat shield panel to the heat shield panel at each side, then disengage and detach the panel.

(b) Remove the row of bolts, flat washers, dampers and thin washers which secure one of

the partly released heat shields, then disengage and detach the panel.

(c) Repeat (b) for the remainder of the heat shield panels.

(d) If items on the exhaust diffuser outer case prevent removal of the heat shield panel(s) from the engine, secure the panel(s) to give clearance at the spherical joint flange for removal of the securing bolts.

(10) Apply release agent A to the nuts and bolts which secure the spherical joint flange to the exhaust diffuser outer case and allow time to soak to facilitate removal.

(11) Remove the engine power pitot tube (Ref. Fig. 403).

(a) Unscrew the union nuts at the four pitots.

(b) Detach tube clamp assemblies from support brackets at three positions.

(c) Support tube and remove the two nuts and bolts which secure the tube integral brackets at the two upper positions.

(d) Remove tube from engine.

(12) Remove the spherical joint flange from the exhaust diffuser outer case.

(a) Support the spherical joint flange and remove nuts and bolts which secure flange to exhaust diffuser outer case; detach brackets, as bolts are removed, and identify each bracket as shown in the illustration (Ref. Fig. 404).

(b) Detach the spherical joint flange from the diffuser outer case.

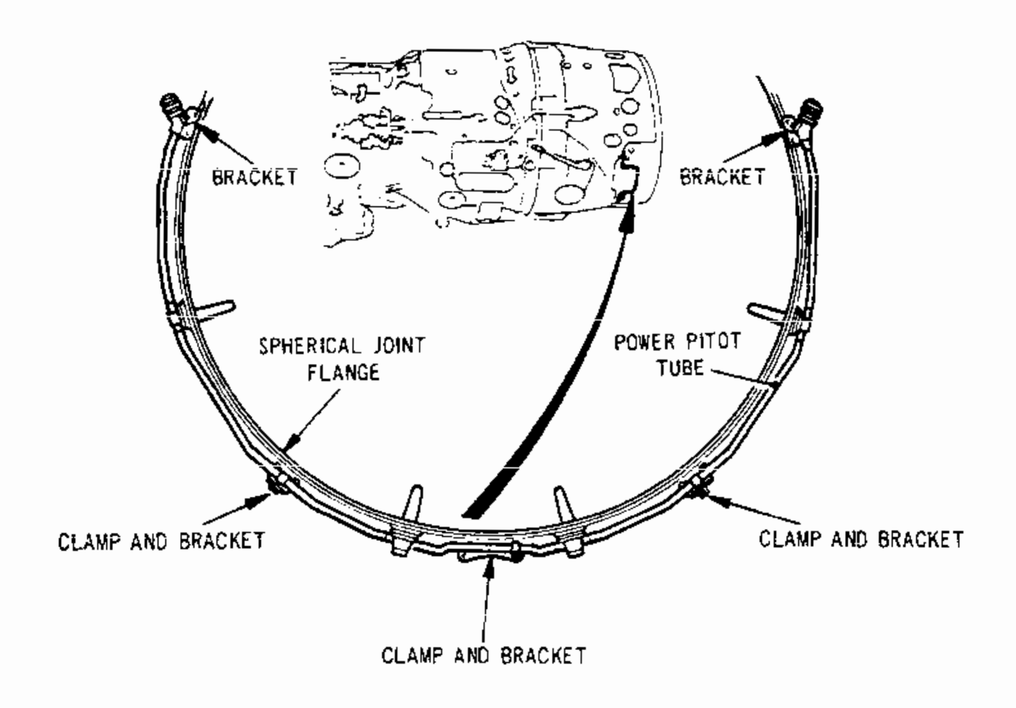
B. If New Spherical Joint Flange to be Installed, Transfer Attached Items to Replacement Flange.

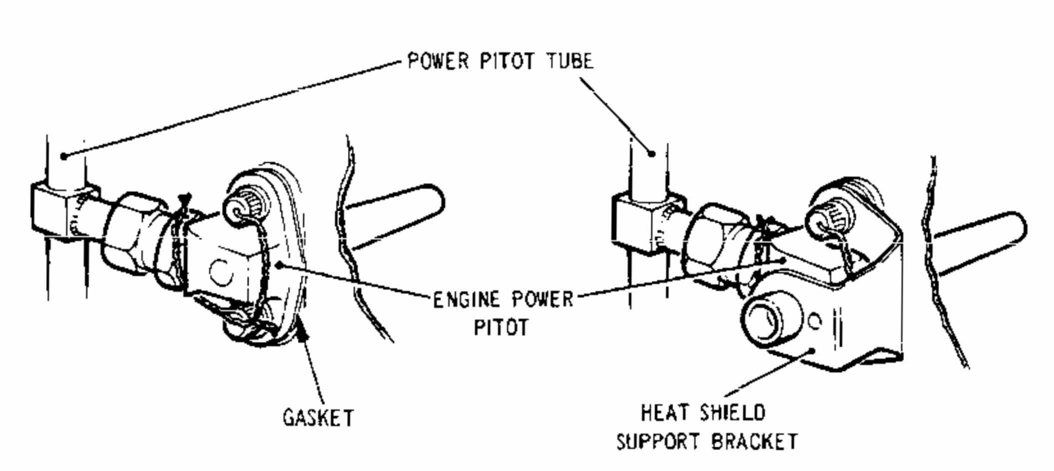
(1) Remove items from the spherical joint flange.

(a) Remove the four engine power pitots (Ref. Fig. 403).

(i) Remove the two bolts securing each of the

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Power Pitots and Tube Location Details
Figure 403

CR 34022/00A

BOLT HOLE POSITIONS 1

100 10

U A

90 20

T B

S C

80 30

D

R E

Q 66 65 44 40 F

70

P G

N M 60 L K J 50 H

SHORT BOLT

TWO LONG BOLTS

DIAGRAMMATIC VIEW LOOKING FORWARD
ON REAR FLANGE OF EXHAUST DIFFUSER

CMR 72 54 01 4 DAMO

Positions of Brackets on Flange of Spherical
Joint Flange
Figure 404

four engine power pitots and, at one position, the bracket, then withdraw the pitots and gaskets.

(b) Remove the primary nozzle control signal pitot (Ref.Fig.405).

(i) Unscrew the two bolts which secure the pitot and the union, then remove the bolts and the union from the probe.

(ii) Withdraw the probe from the spherical joint flange; avoid damage to the flanged pin.

(c) Remove the pressure tapping connector (Ref.Fig.405).

(i) Remove the two securing bolts, then withdraw the connector.

(d) Remove the nozzle supply pipes support bracket (Ref.Fig.405).

(i) Remove the four bolts and the support bracket.

(e) Remove the two jet pipe thermocouple blanking covers.

(i) Remove the four bolts from each blanking cover, then remove the two blanking covers and, at the lower position, the gasket.

(f) Remove the flanged connection and bracket (Ref. Fig.405).

(i) Remove the five bolts, flanged connection and bracket.

(g) Remove the nine heat shield support brackets.

(i) Remove the nuts, bolts and heat shield support brackets from the spherical joint flange brackets. Note the position from which each bracket was removed.

R (h) Remove the support block.
R

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SUPPORT BLOCK

P7 PROBE (P.N.C.)

FLANGE PIN

UNION

A

B

CONNECTOR

NOZZLE SUPPLY PIPES SUPPORT BRACKET

G

D

B

C

A

F

D AND E

G

C

VIEW ON FRONT FACE OF SPHERICAL JOINT FLANGE

TYPICAL BLANKING COVER

FLANGED CONNECTION

GASKET

BRACKET

E

F

D

Removing Items from Spherical Joint Flange
Figure 405

(i) Remove the four bolts which secure the support block to the spherical joint flange, then remove the support block.

(j) Remove the two additional pitot blanking covers (if installed).

(i) Remove the two bolts which secure each of the two blanking covers, then remove the covers.

(2) Assemble items to spherical joint flange to be installed.

(a) Support block.

(i) Apply lubricant A to the four attachment bolts.

(ii) Position the support block on the spherical joint flange and secure with four bolts.

(iii) Torque-tighten the bolts to between 90 and 100 lbf in. (10,2 and 11,3 N.m) and wire-lock.

(b) Heat shield brackets.

R (i) Apply lubricant A to attachment nuts.

(ii) Position the nine heat shield support brackets on the spherical joint flange, at the locations from which they were removed, then retain each bracket with two bolts and self-locking nuts.

R (iii) Torque-tighten the nuts to 100 lbf in.
R (11,5). Locking (Run-down) torque to
R 3,5 lbf in. (0,4 Nm).

(c) Flanged connection and bracket (Ref. Fig.405).

(i) Apply lubricant B to attachment bolts.

(ii) Position the heat shield mounting bracket on the flanged connection and secure the bracket and flanged connection to the spherical joint flange with five bolts, lightly tightened; use the two longer bolts at the bracket positions.

(iii) Torque-tighten the bolts to between 120 and 130 lbf in. (13,6 and 14,7 N.m) and wire-lock.

(d) Jet pipe thermocouple blanking covers (Ref. Fig.405).

(i) Apply lubricant B to the eight attachment bolts.

(ii) Assemble the two blanking covers to the spherical joint flange, with a gasket interposed at the lower position and the heat shield support bracket positioned at the upper location, then secure with eight bolts lightly tightened.

(iii) Torque-tighten the bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m) and wire-lock.

(e) Nozzle supply pipes support bracket (Ref. Fig.405).

(i) Apply lubricant B to the four attachment bolts.

(ii) Position the support bracket on the spherical joint flange, with the three holes aligned fore and aft, then secure with four bolts lightly tightened.

(iii) Torque-tighten the bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m) and wire-lock.

(f) Pressure tapping connector (Ref. Fig.405).

R (i) Apply lubricant A to the two attachment bolts.

(ii) Position the connector on the spherical joint flange and secure with two bolts lightly tightened.

R (iii) Torque-tighten the bolts to 100 lbf in.

R (11,5 N.m) and wire-lock.

(g) Primary nozzle control signal pitot (Ref. Fig.405).

R (i) Apply lubricant A to the two attachment bolts.

(ii) Insert the pitot into the aperture in the spherical joint flange and locate the stepped pin on the pitot flange in the hole in the spherical joint flange.

(iii) Position the union on top of the pitot, then secure the union and the pitot to the spherical joint flange with two bolts lightly tightened.

R (iv) Torque-tighten the bolts to 100 lbf in.
R (11,5 N.m) and wire-lock.

(h) Engine power pitots (Ref. Fig.403).

R (i) Apply lubricant A to the eight attachment bolts.

(ii) Assemble a gasket to each of the four pitots, then insert the pitots into the apertures in the spherical joint flange.

(iii) With the heat shield support bracket in position on the applicable pitot, secure each of the four pitots with two bolts lightly tightened.

R (iv) Torque-tighten the bolts to 100 lbf in.
R (11,5 N.m) and wire-lock.

(j) Additional pitot blanking covers (if required).

R (i) Apply lubricant A to attachment bolts.

(ii) Position the two blanking covers in the spherical joint flange, at approximately the ten o' clock and two o' clock positions, then secure each with two bolts lightly tightened.

R (iii) Torque-tighten the bolts to 100 lbf in.
R (11,5 N.m) and wire-lock.

C. Install the Spherical Joint Flange.

(1) Assemble spherical joint flange to exhaust diffuser outer case.

(a) Check that the fuel drain pipe is secured to the spherical joint flange with a bolt and washer and that the bolt is wire-locked.

R (b) Apply lubricant A to the spherical joint flange attachment nuts.

(c) Align locating pin hole in the front face of the spherical joint flange with the shouldered pin in the rear face of the exhaust diffuser outer case, then engage the pin in the hole and temporarily secure the flange to the outer case with four bolts and self-locking nuts.

(d) Assemble the brackets, identified in paragraph 2.A.(12) and bolts to the flange (Ref. Fig.404) and secure each bolt with a self-locking nut lightly tightened; insert the bolts from the rear of the flange so that the nuts are towards the front of the engine. Use the two longer bolts at positions numbered 65 and 66 and the shortest bolt at position 44.

R (e) Torque-tighten the nuts to 100 lbf in. (11,5 N.m).

(2) Install the engine power pitot tube (Ref. Fig.403).

(a) Apply lubricant A to the threads of the pitot
R unions and to the nuts and bolts.

(b) Position the tube around the spherical joint flange, then screw the tube union nuts onto the four power pitots. Torque-tighten the union nuts to between 190 and 210 lbf in. (21,5 and 23,7 N.m) and wire-lock.

(c) Insert a bolt through each of the two integral brackets and the brackets secured to the flange, at the tube upper positions, then secure each bolt with a nut. Torque-tighten the nuts to
R 100 lbf in. (11,5 N.m).

(d) Attach the three tube clamp assemblies, at the positions shown in (Ref. Fig.403) and secure with bolts and self-locking nuts. Torque-tighten

R the nuts to 100 lbf in. (11,5 N.m).

(3) Install the ten heat shield panels (Ref. Fig.406).

WARNING: WASH HANDS AFTER USING LUBRICANT G. LUBRICANT CONTAINS COPPER AND LEAD AND IS TOXIC.

(a) Apply lubricant B to the heat shield panel attachment bolts and lubricant G to the inside faces of each panel to cover the area of over-lap when the panels are installed.

NOTE: The heat shield panels are numbered in a clockwise direction, when viewed from the rear, with No.1 panel at the top position.

(b) Slot the No.1 panel into No.2 panel, then position the joint mounting holes over the bosses on the front and rear mounting brackets.

(c) Ease the rear mounting hole clear of the boss, feed a mesh damper onto the boss, followed by a thin washer with its concave side towards the damper, then press the panels back onto the boss.

(d) Place a thin washer, concave side facing out-wards, followed by a mesh damper, onto the boss, then secure the assembly with a bolt and flat washer lightly tightened. Ensure that the dampers and thin washers do not interfere during the tightening procedure and that the flat washer is clamped onto the boss by the bolt.

(e) Use the procedures stated in paragraphs (c) and (d) for the front mounting point of the No.1 and 2 panel joint.

(f) Install the remaining heat shield panels in sequence, using the procedures stated in paragraphs (b), (c), (d) and (e), noting the following special features:

(i) At three positions shown in the illustration (Ref. Fig.406) assemble a flat washer to the mounting bracket boss before the first mesh damper and thin washer.

CR 34023/00B

SPHERICAL JOINT FLANGE

ADDITIONAL FLAT WASHER
AT POSITIONS MARKED ✱

CONTAINMENT SHIELD

PANEL NO 1 (TOP)

FUEL DRAIN PIPE (PLATE)

THIN WASHER

FLAT WASHER

DAMPER

BOSS

BRACKET

TYPICAL ATTACHMENT OF
HEAT SHIELDS TO BRACKETS

PILLAR BOLT

BOTTOM HEAT SHIELD
SUPPORT BRACKET

CHANNEL ASSEMBLY

PANELS

APPLICATION OF LUBRICANT 'G'

ENGAGEMENT OF ADJOINING PANELS

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Installing Heat Shields
Figure 406

R

(ii) At the rear mounting point of panel No.7, assemble the bottom heat shield support bracket, positioned with its open end towards the bottom of the engine, beneath the bolthead in place of a flat washer.

(iii) At the rear and centre mounting point for panels No.4 and 5, assemble the channel assembly, positioned with the channel towards the bottom of the engine, beneath the boltheads in place of the flat washers.

(iv) At the rear mounting point for panels No.5 and 6, install the pillar bolt in place of the machine bolt.

(g) Torque-tighten the panel retaining bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(4) Install the reheat injection system (Ref.73-12-06, Removal/Installation).

R (5) Paragraph deleted.

(6) Jet pipe drains tube section and flexible drain hose clamp (Ref.Fig.402).

(a) Install jet pipe drains tube section (Ref. 71-00-02, Concorde Power Plant Build-up Manual).

(b) Install the clamp which secures the flexible drain hose to the bottom of the spherical joint flange (Ref.71-00-02, Concorde Power Plant Build-up Manual).

(7) Install reheat flame detector.

CAUTION: TAKE CARE NOT TO BEND REHEAT FLAME DETECTOR CONDUCTOR AT ANY TIME. BENDING COULD RESULT IN DETERIORATION OF CONDUCTOR INSULATION.

(a) Install detector (pre S.B. OL.593-77-10 and 77-11 standard).

(i) Apply lubricant S to flange attachment bolts.

(ii) Assemble detector to spherical joint

flange.

(iii) Secure flange with four bolts torque-tightened to 105 ± 18 lbf in. (12 ± 2 N.m). Wire-lock bolts in pairs.

(b) Install detector (S.B.OL.593-77-10 and 77-11 standard).

(i) Apply lubricant S to flange attachment bolts.

(ii) Assemble detector to spherical joint flange.

(iii) Align pitot tube clamp assembly and support bracket to detector flange.

(iv) Secure flange and bracket with bolts torque-tightened to 105 ± 18 lbf in. (12 ± 2 N.m). Wire-lock bolts in pairs.

(v) Torque-tighten pitot tube clamp assembly
R bolt to 100 lbf in. (11,5 N.m) with
R lubricant A applied.

(c) Secure flame detector conductor clamp assembly to supporting bracket with bolt, washer and nut, torque-tightened to between 67 and 73 lbf in. (7,6 and 8,2 N.m) with lubricant B applied.

(8) Ensure that distance between flame detector and reheat stabilizer is within limits detailed in 76-15-02, Inspection/check.

(9) Install the section of purging air tube between the spherical joint flange and the union connection.

(a) Apply lubricant A to union connections and lubricant B to clamp assembly items.

(b) Position tube on engine and engage union nuts hand-tight.

(c) Attach clamp assemblies at following positions:

(i) Bracket on LP turbine bearing hot vent elbow.

(ii) Bracket on exhaust diffuser/spherical joint flange.

(d) Torque-tighten clamp assembly items to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(e) Torque-tighten union nut at union connection to between 190 and 210 lbf in. (21,5 and 23,5 N.m) and union nut at connection on spherical joint flange to between 140 and 160 lbf in. (15,8 and 18,1 N.m). If a new tube is installed, after initial torque-tightening of tube union nut to joint flange, slacken nut and repeat torque-tightening, again slacken nut and finally torque-tighten to between 140 and 160 lbf in. (15,8 and 18,1 N.m).

(f) Wire-lock union nuts.

(10) Install jet pipe thermocouple lead (Ref. 77-21-03, Removal/Installation).

(11) Install the two independently mounted heat shield panels to the side and bottom positions of the spherical joint flange (Ref. 71-32-02, Removal/Installation).

(12) Observe the safety precautions and install the engine (Ref. 71-00-12, Removal/Installation).

3. <u>Spherical Joint Flange Seal Cover - Removal/Installation (Ref. Fig. 407)</u>

A. General

Where pre S.B.OL.593-72-14040-150 standard procedure is given it relates to S.B.OL.593-72-70 and 72-108 standard bolted seal covers and requires reheat jet pipe removal.

B. Tools and Equipment

Torque wrench (0 to 3 daN.m in range)	-
Circuit breaker safety clips	-

C. Prepare to Remove Seal Cover

(1) Open engine bay rear door (Ref. 71-00-00, Servicing).

(2) On engines to pre S.B.OL.593-72-14040-150 standard remove reheat jet pipe (Ref. 78-11-01, Removal/Installation).

D. Remove the seal cover or seal cover section from the spherical joint flange as follows :

(1) Remove bolts and washers.

(2) On engines to pre S.B.OL.593-72-14040-150 standard, remove the seal cover.

(3) On engines to S.B.OL.593-72-14040-150 standard, remove the seal cover section.

E. Install the Seal Cover.

(1) Install the new seal cover or seal cover section on its support and attach it on the spherical joint flange using the bolts and the washers.

(2) Apply lubricant S to attachment bolts and torque-tighten them to between 0,45 amd 0,50 daN.m (40 and 45 lbf.in.).

F. Complete the Installation.

(1) On engines to pre S.B. OL. 593-72-14040-150 standard, install the reheat jet pipe (Ref.78-11-01 Removal/ Installation).

(2) Close engine bay rear door (Ref. 71-00-00, Servicing).

SPHERICAL FLANGE
WASHER
BOLT
SB.72-108
SEAL COVER
SECTION A A

CR 34008/00B

SPHERICAL FLANGE
WASHER
BOLT
PRE SB.72-108
SEAL COVER
SECTION A A

A
A

CMR 72 54 01 4 GAMO

Spherical Joint Flange Seal Cover
Installation Detail
Figure 407

SPHERICAL JOINT FLANGE - INSPECTION/CHECK

1. General

This chapter defines the inspection to be carried out and the acceptance criteria related to damages affecting spherical joint flange.

2. Prepare Spherical Flange Adapter for Examination

A. Electrically isolate the engine and exhaust assembly services indicated in Table 601 by tripping the circuit breakers affecting engines in the nacelle upon which work is being carried out. Fit circuit breaker safety clips.

SERVICE	PANEL	CIRCUIT BREAKER	MAP REF
ENGINE NO.1			
REHEAT CONT.	15-216	1K 1542	E 9
REHEAT AMP SUP.	14-215	1K 1541	C13
REHEAT IGNITION SUP PH A	14-215	1K 1543	B13
REHEAT IGNITION SUP PH C	14-215	1K 1544	F12
ENGINE NO.2			
REHEAT CONT.	15-215	2K 1542	D15
REHEAT AMP SUP.	13-215	2K 1541	B14
REHEAT IGNITION SUP PH A	13-215	2K 1543	A14
REHEAT IGNITION SUP PH C	13-215	2K 1544	E14
ENGINE NO.3			
REHEAT CONT.	15-215	3K 1542	D16
REHEAT AMP SUP.	13-216	3K 1541	B 5
REHEAT IGNITION SUP PH A	13-216	3K 1543	A 5
REHEAT IGNITION SUP PH C	13-216	3K 1544	F 6
ENGINE NO.4			
REHEAT CONT.	15-216	4K 1542	E10
REHEAT AMP SUP.	14-216	4K 1541	D 7
REHEAT IGNITION SUP PH A	14-216	4K 1543	A 6
REHEAT IGNITION SUP PH C	14-216	4K 1544	E 7

Circuit Breakers
Table 601

WARNING: MAKE SURE THAT NO SOURCE OF COMPRESSED AIR IS CONNECTED TO THE GROUND CONNECTIONS OF THE TWIN

SECONDARY NOZZLE.

B. Carry out the safety precautions and work sequences required for access to the jet pipe as detailed in 71-00-00, Servicing.

WARNING: HIGH ENERGY IGNITION EQUIPMENT CAN BE LETHAL. COMPLY WITH THE SAFETY PRECAUTIONS DETAILED IN CHAPTER 12.

C. Display a suitable placard on the engine starting panel indicating that personnel are working on the engines and in the twin secondary nozzle area.

3. Examine the Spherical Joint Flange

A. Visual Inspection

Get into the reheat jet pipe and inspect the spherical joint flange for damage.

(1) Check the condition of the sealing strip attachment tabs.

R (2) Inspect the sealing strip attachment rivets and
R bolts.

(3) Inspect the sealing strip for condition.

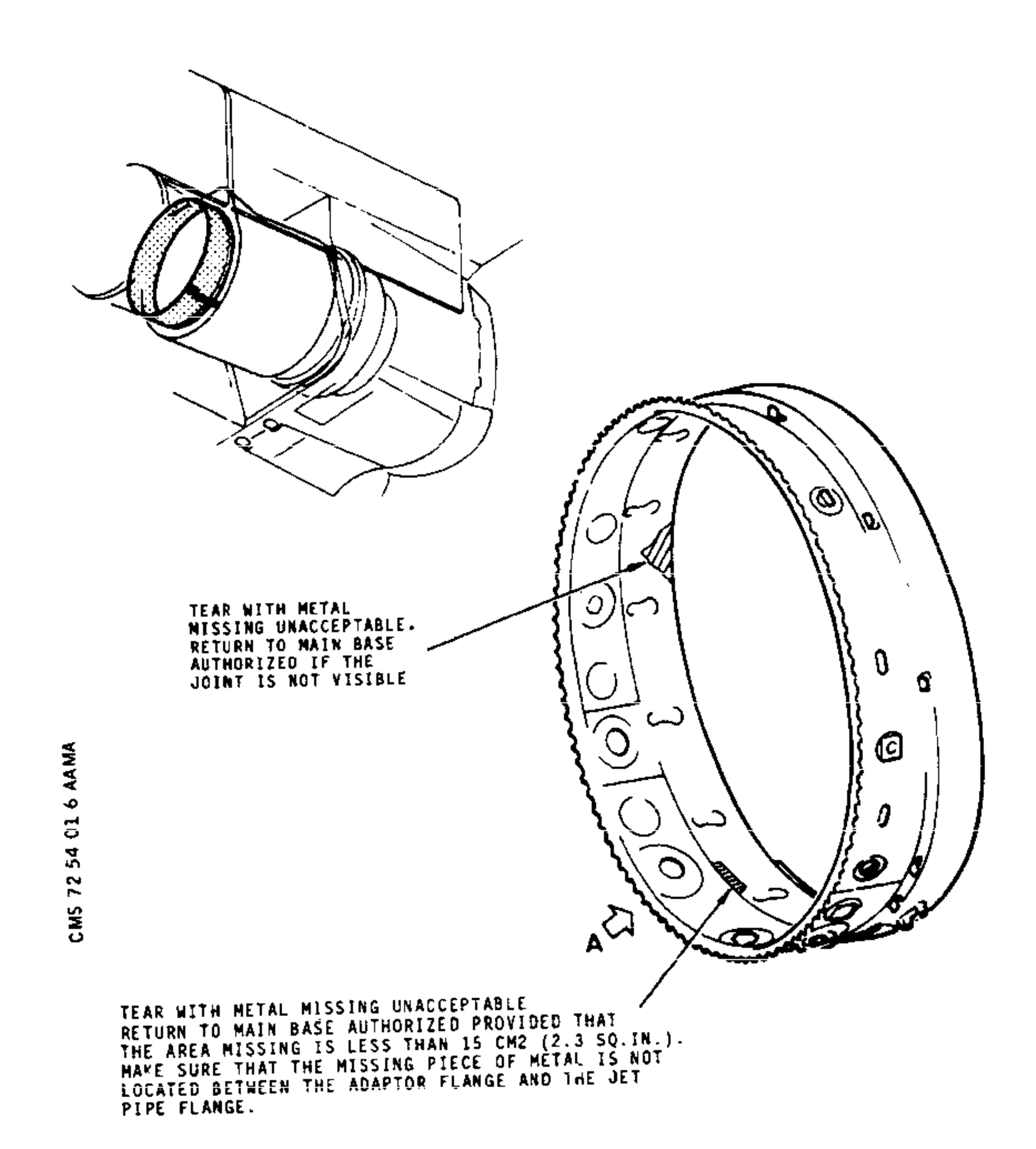
4. Acceptance Criteria (Ref. Fig. 601)

A. Compare the spherical flange damage with criteria specified on the illustration (Ref. Fig. 601) and carry out the approved repairs detailed in 72-54-01, Approved Repairs, as soon as possible.

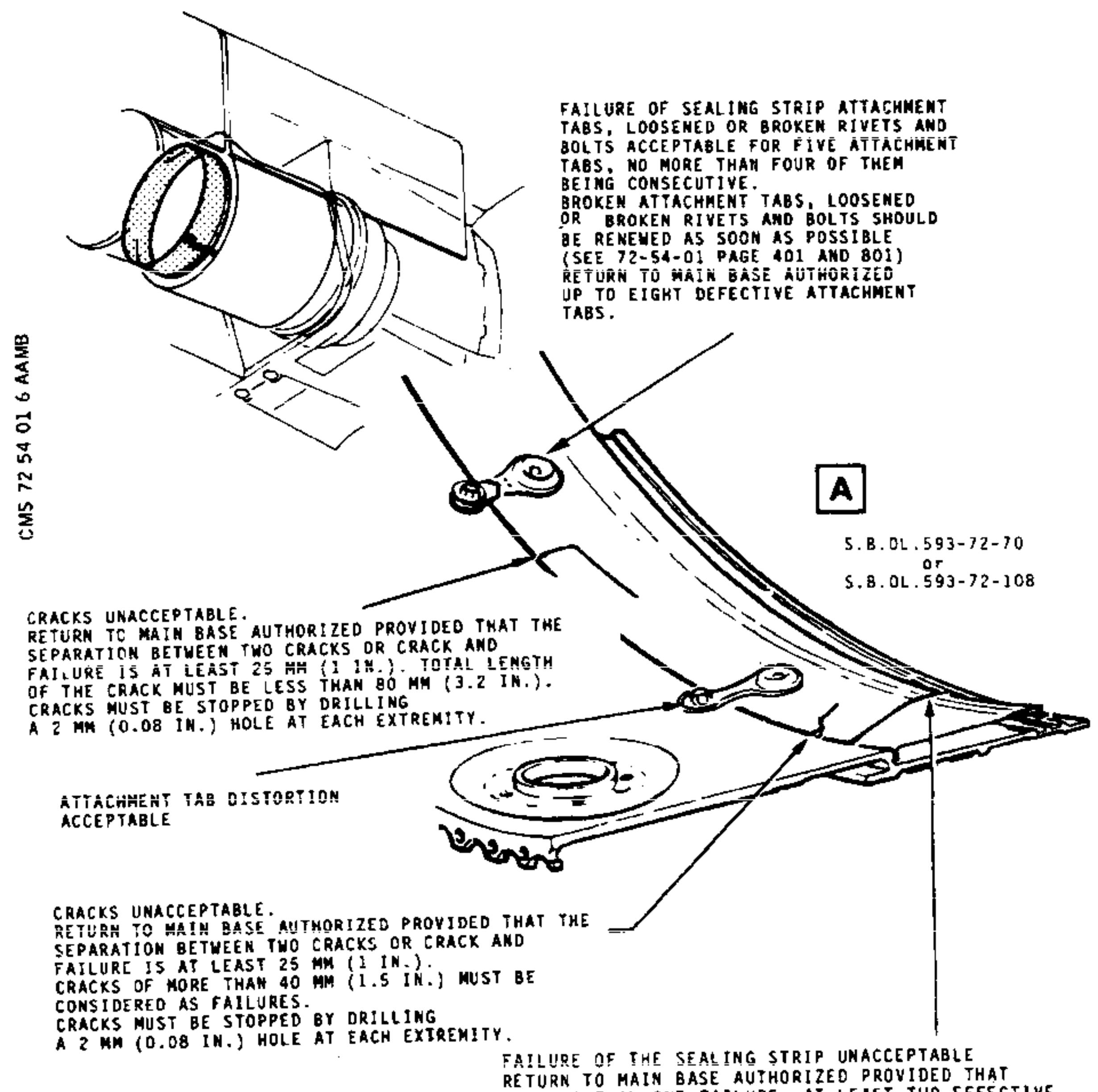
B. If damage exceeds the specified dimension

(1) On spherical flange modified SB.OL.593-72-70 or SB. OL.593-72-108 remove and replace the sealing strip. (Ref.72-54-01 Removal/Installation).

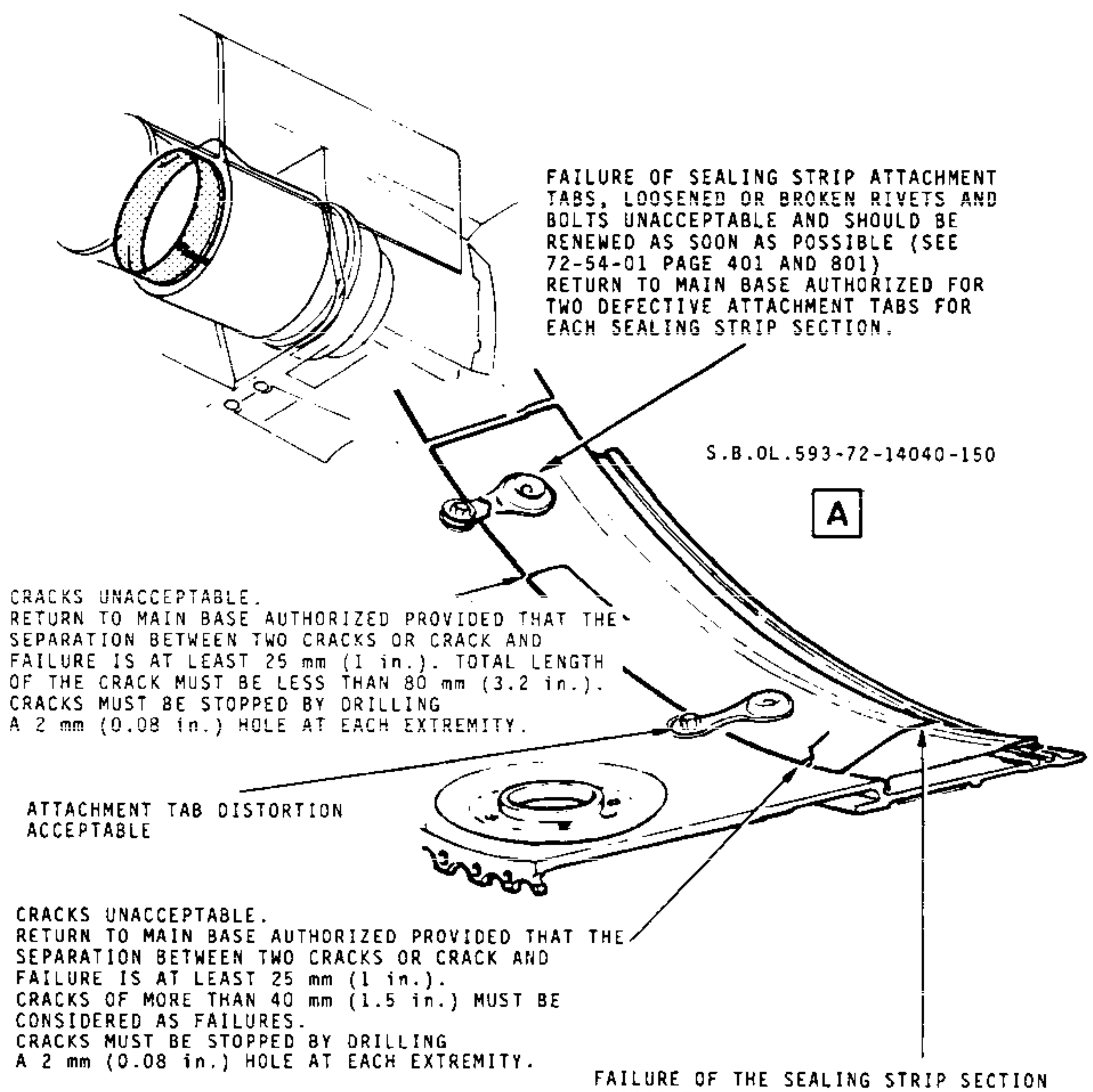
(2) On spherical flange modified SB.OL.593-72-14040-150 remove and replace the sealing strip section (Ref. 72-54-01 Removal/Installation).



Inspection of the Spherical Joint Flange
Acceptance Criteria (Sheet 1 of 3)
Figure 601



Inspection of the Spherical Joint Flange
Acceptance Criteria (Sheet 2 of 3)
Figure 601



IF THE DEFECTS ARE OUTSIDE LIMITS REMOVE THE SEALING STRIP SECTION UP TO FIVE FLIGHTS AUTHORIZED WITH ONE SEALING STRIP SECTION REMOVED.

Inspection of the Spherical Joint Flange
Acceptance Criteria (Sheet 3 of 3)
Figure 601

B

R

SPHERICAL JOINT FLANGE - APPROVED REPAIRS

1. General

The instructions given in this chapter deal with the renewal of the rivets attaching the sealing strip to the spherical joint flange and are valid for the different standards of sealing strips fitted to the spherical joint flanges. On pre S.B.OL.593-72-70 spherical flanges, the sealing strip is attached by tabs riveted at both ends. Tabs on spherical flanges modified to S.B.OL.593-72-70, S.B.OL.593-72-108 or S.B.OL.593-72-14040-150 are bolted by one end to the spherical flange, with the other end riveted to the sealing strip.

R B A. The material used in the construction of the Spherical
R B Joint Flange Seal cover is a nickel based alloy with a
R B high chromium and colbalt content. Consequently when
R B drilling this material, conventional drills should not
R B be used due to a rapid deterioration of the cutting
R B edges causing local overheating and work hardening of
R B the material. The following procedure should be followed
R B when drilling in this area.

R B (1) Tools and Equipment

	Part Number	Size
Solid Carbide Master Spiral Drill	240-0255	46
	240-0345	1/8"
	240-0380	25
	240-0395	5/32"
	240-0410	20
	240-0415	19
	240-0435	16
	240-0465	11
	240-0490	13/64"

R B Ingersoll Rand Pistol Windy.

R B (2) Procedure

R B (a) Centre punch item to be drilled if possible.

R B (b) Set speed of windy to approx. 2000-2500 RPM by
R B regulating flow of air.

R B (c) Apply cutting medium e.g. Treflux, generously.

R B (d) Apply a continuous steady pressure to drill.
R B Once cutting has commenced it should not be
R B stopped until the hole has been completely
R B cut.

R B **CAUTION:** FAILURE TO FOLLOW THIS PROCEDURE WILL
R B CAUSE THE MATERIAL BEING CUT TO HEAT
R B UP AND WORK HARDEN AS COOLING TAKES
R B PLACE AFTER DRILLING HAS STOPPED.

R B **NOTE:** Any drills which become damaged or lose
R B their cutting edge must not be discarded.
R B Return to stores (WH 16) for re-sharpening

2. Renewal of the rivets attaching the sealing strip to the spherical joint flange (Ref. Fig. 801)

PART REQUIRED FOR REPAIR

DESIGNATION	PART NO
"CHERRY LOCK" rivet CR 2743-5-2	649-772-069-0
"CHERRY LOCK" rivet CR 2743-5-4	649-772-303-0
"CHERRY LOCK" rivet CR 2839-5-2	649-772-083-0
"CHERRY LOCK" rivet CR 2839-5-4	649-772-085-0
"CHERRY LOCK" rivet CR 2839-6-4	649-772-090-0
"HI-LOK" screw HL 40-5-3	649-781-291-0
"HI-LOK" screw HL 40-6-3	649-781-297-0
"HI-LOK" screw HL 140-6-3	649-781-401-0
"HI-LOK" nut HL 97-5	649-782-257-0
"HI-LOK" nut HL 97-6	649-782-258-0
"HI-LOK" nut HL 197-6	649-782-281-0
Washer	525-003-738-0
Washer	525-203-192-0
Washer	525-203-200-0
Tabs	301-182-600-0
Tabs	301-182-601-0
Tabs	525-203-193-0

A. Removing the damaged rivets.

(1) Using a pneumatic grinding hand tool and a rivet drift, machine out the head of the deteriorated rivets and then drive out the rivet shanks.

B. Installing the rivets securing the attachment tabs to the spherical joint flange. (Spherical joint flange Pre S.B. OL.593-72-70).

(1) Visually check the condition of rivet holes in both the tab and spherical joint flange.

(a) If the rivet holes are not damaged or out of round install rivets CR 2743-5-4 (Refer to para. D.).

(b) If the rivet holes are damaged or out of round install rivets CR 2839-5-4 or rivets 2839-6-4 as per the following method.

(i) Using a pneumatic hand-held drilling machine fitted with a right-angles drilling head, counterbore the existing rivet holes in tab, spherical joint flange and washer, to a diameter comprised between 4,47 and 4,57 mm (0.176 - 0.180 in) for rivets CR 2839-5-4 or to a diameter comprised between 5,1 and 5,2 mm (0.201 - 0,205 in) for rivets CR 2839-6-4.

NOTE: This operation is to be carried out using a high-speed drill, grade M43 or M42, precision ground on its four cutting edges with a 118 deg tip angle and a 10 deg rake angle.

(ii) Using a scraper, carefully deburr the hole edges.

(iii) Locate a washer No. 525-203-200-0 in position and fasten assembly with rivets CR 2839-5-4 or rivets CR 2839-6-4 (Refer to para.D).

C. Installing the rivets securing the attachment tabs to the sealing strip.

(1) Visually check the condition of the rivet holes in both tabs and sealing strip.

(a) If the rivet holes are not damaged or out of round install rivets, CR 2743-5-2 (Refer to para.D).

(b) If the rivet holes are damaged or out of round prepare to install rivets CR 2839-5-2 as per the following method:

(i) Counterbore the existing rivet holes in both the sealing strip and tab, to a diameter comprised between 4,47 and 4,57 mm (0.176 - 0.180 in).

NOTE: The characteristics of the drill to be used are identical to those specified in para 2.B (2).

(ii) Using a scraper, carefully deburr the hole edges.

(iii) Locate a washer No. 525-003-738-0 in position and fasten assembly using rivets CR 2839-5-2 (Ref. to para D).

D. Installation of the Cherrylock blind rivets. (Ref. Fig. 802)

(1) These rivets are lubricated at manufacture with a special lubricant. Prior to fitting them, make sure that this lubricant is present.

NOTE: Excessive heat, degreasers and cleaning agents are detrimental to the integrity of this lubricant.

CAUTION: DO NOT RE-LUBRICATE THE DEFECTIVE RIVETS.

(2) Check visually that the rivets are in good condition. Rivets showing scratches, impact marks, salvaged rivets and non-lubricated rivets are to be scrapped.

(3) Perfectly position the parts to be assembled prior to carrying out the riveting.

(4) Using a "Cherrylock" pneumatic riveting gun, type G 695 B, fitted with a riveting nose-piece H 690-5 U, or H690-6U for rivets 2839-6-4, install the rivets as shown on the illustration (Ref. Fig. 801).

NOTE: The riveting gun air supply pressure to be comprised within 6 and 8 bars (87 and 116 p.s.i.).

(5) Inspect the installed rivets (Ref. Fig. 803).

(a) A light gap between the rivet head and the bearing surface is acceptable provided that:

(i) Max. gap value does not exceed 0,1 mm (0.004 in).

(ii) The rivet head bears, at least, on 60 per cent of its circumference.

CHERRYLOCK RIVET CR 2743-5-2 or
CR 2839-5-2
CAUTION : THE RIVET HEAD MUST
BE FLUSH WITH THE
SEALING STRIP ADJA-
CENT CONTOUR

A A

CROSS SECTION A-A
AFTER SB.OL.593-72-70

ATTACHMENT TAB
No.301-182-600-0

LOAD SPREADING WASHER
No.301-182-700-0

SEALING STRIP

SPHERICAL JOINT FLANGE

BOLT No.649-092-332-0

FLAT WASHER
No.525-003-738-0

CMS 72 54 01 B AAMA

RIVET DATA				
TYPE	MATERIAL	PROTECTION	DIAMETER mm (in)	DRILLING DIAMETER mm (in)
CR 2743-5-2	NC 15Fe T	MOLYLOTE	3,96(0.156)	4,06 +0,10(0.164) +0 (0.160)
CR 2839-5-2	NC 15Fe	NONE	4,39(0.173)	4,47 +0,10(0.180) +0 (0.176)

Renewal of the Rivets Attaching the Sealing Strip
to the Spherical Joint Flange (Sheet 1 of 3)
Figure 801

CHERRYLOCK RIVET CR 2743-5-2 or CR 2839-5-2
CAUTION : THE RIVET HEAD MUST BE FLUSH WITH THE SEALING STRIP ADJACENT CONTOUR

A

A

CROSS SECTION A-A
AFTER SB.OL.593-72-108

ATTACHMENT TAB
No.301-182-601-0

LOAD SPREADING WASHER
No.301-182-700-0

SEALING STRIP

SPHERICAL JOINT FLANGE

BOLT No.649-092-332-0

FLAT WASHER No.525-003-738-0

CMS 72 54 01 8 AAMB

RIVET DATA				
TYPE	MATERIAL	PROTECTION	DIAMETER mm (in)	DRILLING DIAMETER mm (in)
CR 2743-5-2	NC 15Fe T	MOLYLOTE	3,96 (0.156)	4,06 + 0,10 (0.164) + 0 (0.160)
CR 2839-5-2	NC 15Fe	NONE	4,39 (0.173)	4;47 + 0,10 (0.180) + 0 (0.176)

Renewal of the Rivets Attaching the Sealing Strip to the Spherical Joint Flange (Sheet 2 of 3)
Figure 801

CHERRYLOCK RIVET CR 2743-5-2 or CR 2839-5-2

CAUTION : THE RIVET HEAD MUST BE FLUSH WITH THE SEALING STRIP ADJACENT CONTOUR

A

A

CROSS SECTION A-A
AFTER SB.OL.593-72-108

ATTACHMENT TAB
No.301-182-601-0

LOAD SPREADING WASHER
No.301-182-700-0

SEALING STRIP

SPHERICAL JOINT FLANGE

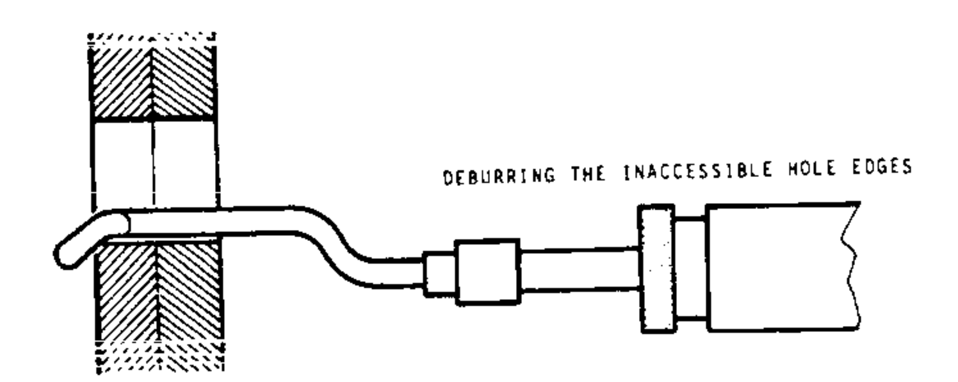
BOLT No.649-092-332-0

FLAT WASHER No.525-003-738-0

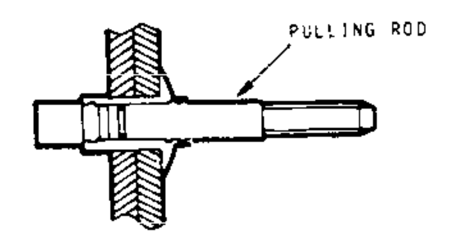
RIVET DATA				
TYPE	MATERIAL	PROTECTION	DIAMETER mm (in)	DRILLING DIAMETER mm (in)
CR 2743-5-2	NC 15Fe T	MOLYLOTE	3,96 (0.156)	4,06 + 0,10 (0.164) + 0 (0.160)
CR 2839-5-2	NC 15Fe	NONE	4,39 (0.173)	4,47 + 0,10 (0.180) + 0 (0.176)

CMS 72 54 01 8 AAMC

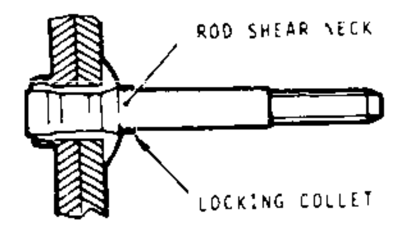
Renewal of the Rivets Attaching the Sealing Strip
to the Spherical Joint Flange (Sheet 3 of 3)
Figure 801



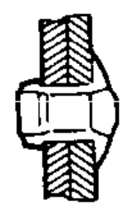
1. LOCATE THE RIVET IN POSITION.



2. PULLING OF THE CENTRAL ROD UNTIL ALIGNMENT OF THE ROD SHEAR NECK WITH THE RIVET HEAD.



3. THE RIVETING NOSE - PIECE AUTOMATICALLY PUSHES BACK THE LOCKING COLLET IN ITS RECESS AND CAUSES SHEARING OF THE ROD.



CMS 72 54 01 8 BAMO

Installation of Cherrylock Rivets
Figure 802

(b) The protrusion of the rivet central rods and collets must be in accordance with the requirements of the illustration (Ref. Fig. 803).

(6) If necessary, machine flush the rivet pulling rod using cutting pliers or a flush - grinding tool "Cherry", type 301 B.

CAUTION: TAKE ALL THE NECESSARY PRECAUTIONS TO AVOID DAMAGE TO THE RIVETS AND/OR THE PARTS. DO NOT GRIND FLUSH THE LOCKING COLLET.

3. Replacement of the Rivets attaching the Sealing Strip Sections to the Spherical Joint Flanges Modified S.B.OL.593-72-14040-150 (Ref. Fig. 804)

A. Removing Damaged Rivets

(1) Remove the Sealing Strip Section on which damaged

rivets must be replaced.(Ref.72-54-01 Page Block 401).

(2) Using a pneumatic grinding hand tool and a rivet drift, machine out the head of the deteriorated rivets and then drive out the rivet shanks.

B. Prepare to Install the "HI-LOK" Screws.

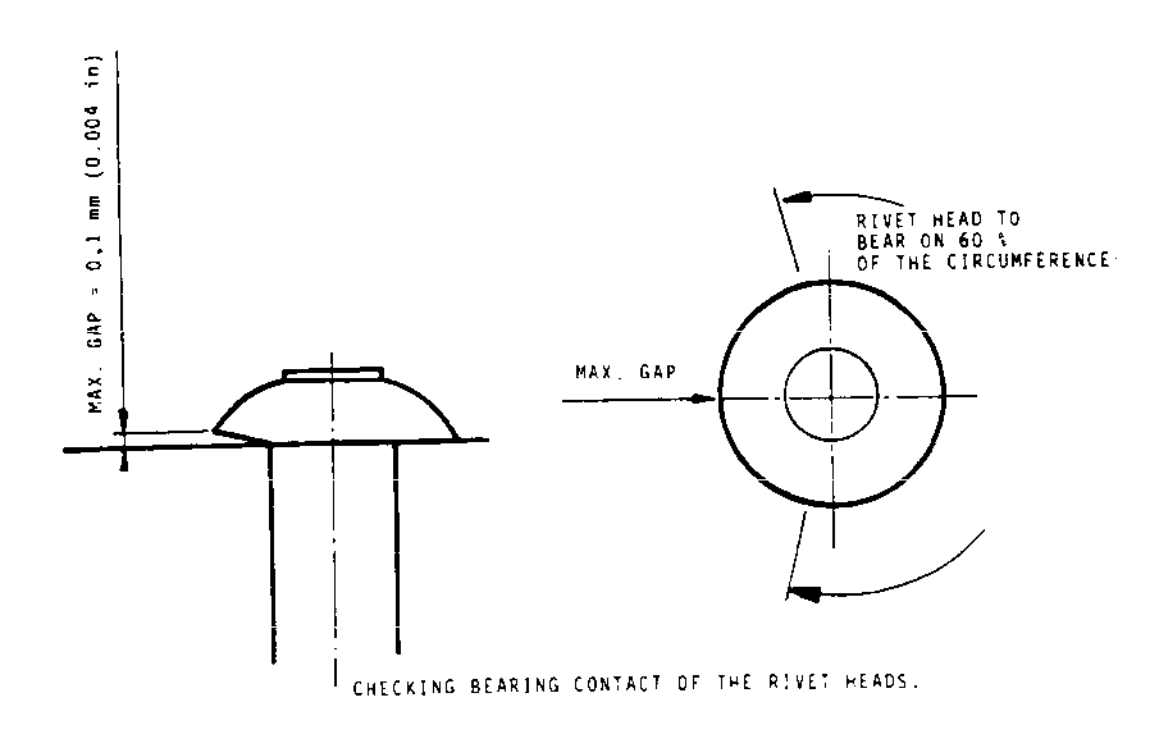
(1) Visually check the condition of rivet holes in both tab and spherical joint flange.

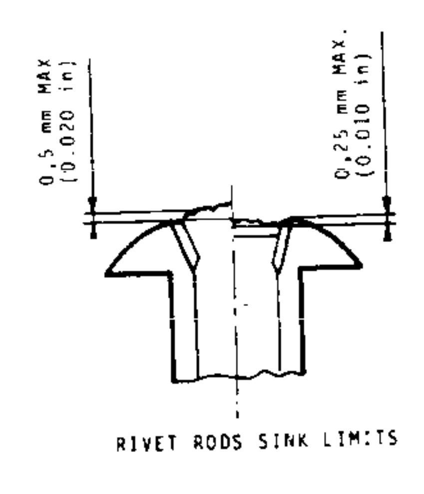
(2) If the rivet holes are not damaged or out of round, install screws HL-40-5-3 associated with nuts HL97-5 (Refer to para C).

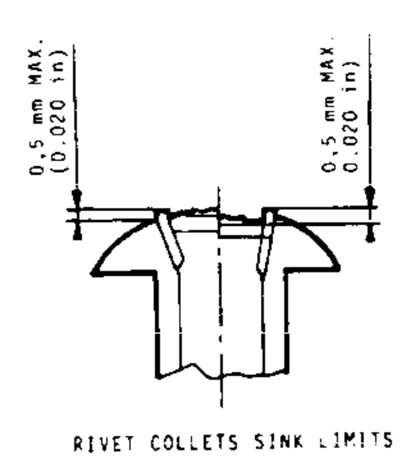
NOTE: It may be necessary to counterbore the holes to a diameter comprised between 4.17 and 4.27 mm (0.164 and 0.168 in). Use the same drill and proceed as described in paragraph (b).

(b) If the rivet holes are damaged or cut of round, install screws HL 40-6-3 associated with nuts HL
R 97-6 or screws HL 140-6-3 associated with nuts
R HL 197-6 as per the following methods:

(b1) Counterbore the two washers and the existing holes in both the sealing strip and tab to a diameter comprised between 4,83 and 4,93 mm (0.190 and 0.193 in.) for screws HL 40-6-3 or to a diameter comprised between 5,16 and 5,26 mm (0.0203 and 0.0207 in.) for







CMS 72 54 01 8 CAMO

Check of Installed Cherrylock Rivets
Figure 803

screws HL 140-6-3.

NOTE : This operation is to be carried out using a high-speed drill, grade M43 or M42, precision ground on its four cutting edges with a 118 deg tip angle and a 10 deg rake angle.

(b2) Using a scraper, carefully deburr the hole edges (Ref. Fig. 805).

(b3) Round off the washer receiving the head of the screw by a radius of 0,4 to 0,5 mm (0.016 to 0.020 in.).

(b4) Install the screw and nut as described in paragraph C.

C. Installing the "HI-LOK" Screws (Ref. Fig. 806)

(1) Check visually that the screws are in good condition. Screws showing scratches, impact marks, discontinuity in the threads are to be scrapped.

NOTE: Surface defects on the screw heads are acceptable provided they are round bottomed, devoid of sharp corners and not deeper than 0,1 mm (0.004 in).

(2) Locate the screws in their respective recesses proceeding as follows:

(a) Locate the rounded off washers on the screw.

(b) Insert the screw through the sealing strip section into tab holes, install the washer, screw the nut on to the screw by a few turns.

(c) Using an appropriate tool, tighten the nut until shearing of its driving collar occurs. To this end, use either :

- The HI-SHEAR installation tool, Model HLH 110-5 and HLH 110-6.
- or a standard 5/16" spanner in conjunction with a 1/16" and 5/64" Allen wrench.

D. Conclusion

(1) Reinstall the Sealing Strip Section (Ref.72-54-01 Page Block 401).

4. Renewal of the Sealing Strip Attachment Tabs

A. Installing attachment tabs on spherical flange Pre S.B.OL.593-72-70.

(1) For installation of the sealing strip attachment tabs to the information (riveting techniques) given in graphs 2.A., B and C. and in the illustration (Ref. Fig. 801).

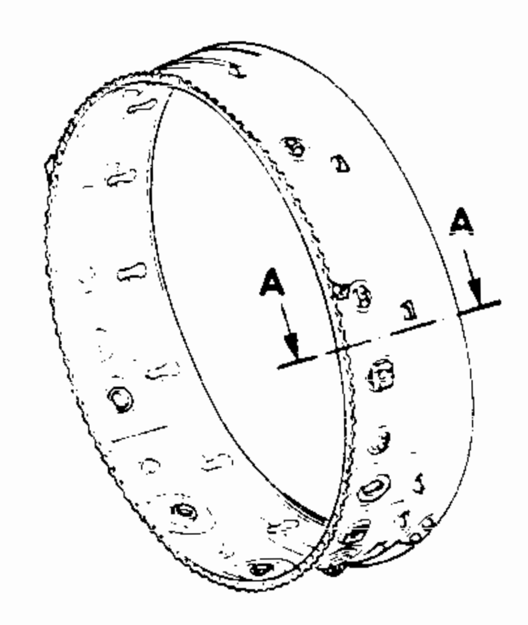
B. Installing attachment tabs on spherical joint flange modified to S.B.OL.593-72-70 or S.B.OL.593-72-108.

(1) For installation of the sealing strip attachment tabs refer to the information (riveting techniques) given paragraphs 2.A and C. and in the illustration (Ref. Fig. 801). The seal cover to Spherical Joint Flange attachment procedure is given in paragraph 3. of chapter 72-54-01, Removal/Installation.

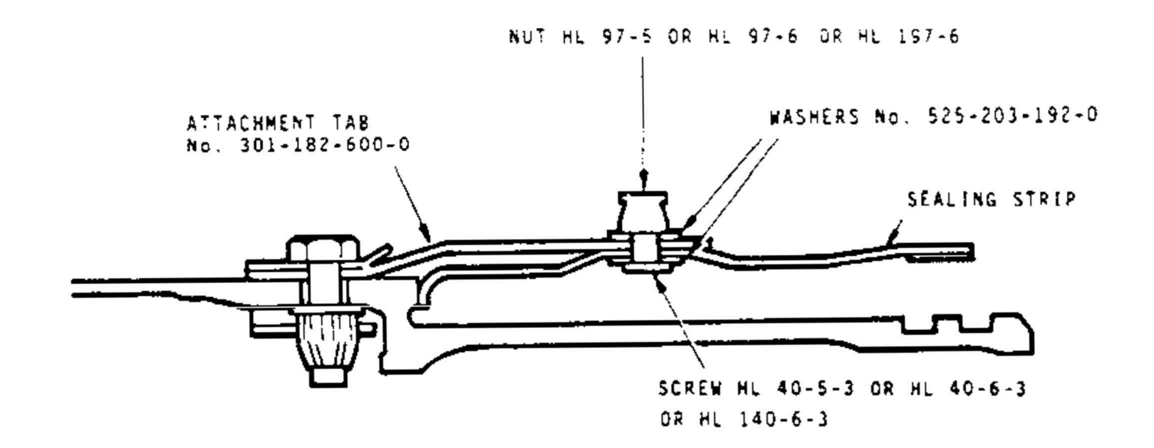
C. Installing Attachment Tabs on Spherical Joint Flange Modified S.B.OL.593-14040-150.

(1) For installation of the sealing strip attachment tabs refer to the information given in paragraph 3 and the illustration (Ref. Fig. 804).

R
R

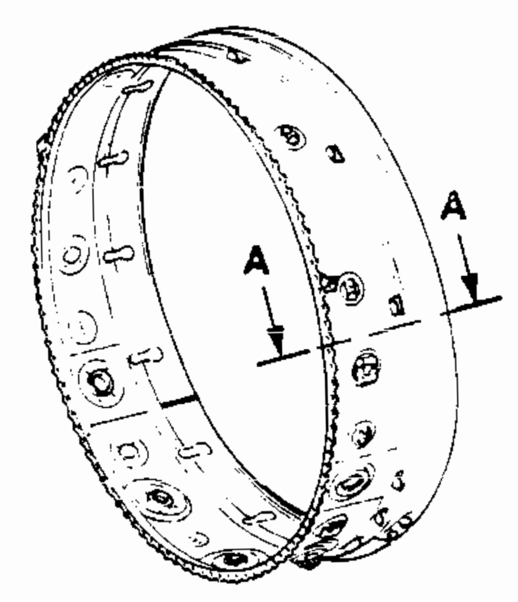


CROSS SECTION A-A
AFTER SB.OL.593-72-70
AND SB.OL.593-14040-150

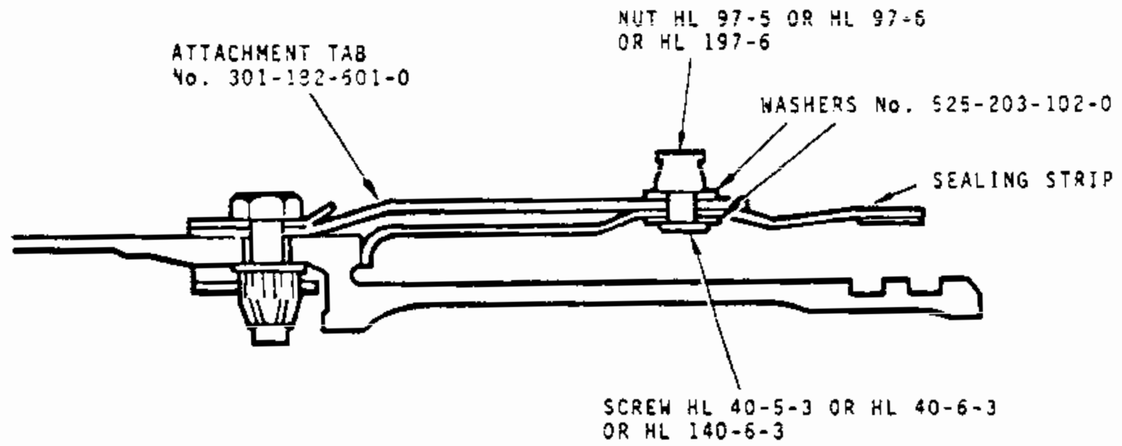


SCREW	MATERIAL	DIAMETER mm (in)	DRILLING DIAMETER mm (in)	NUT
HL 40-5-3	Z6 NCT 25	4,15 (0.1635)	4,17 + 0,1 + 0 (0.168) (0.164)	HL 97-5
HL 40-6-3	Z6 NCT 25	4,81 (0.1895)	4,83 + 0,1 + 0 (0.194) (0.190)	HL 97-6
HL 140-6-3	Z6 NCT 25	5,14 (0.2026)	5,16 + 0,1 + 0 (0.207) (0.203)	HL 197-6

Replacement of Rivets Attaching Sealing Strip
R Section to Spherical Flange, Using "HI-LOK" Screws
R Figure 804 (Sheet 1 of 2)

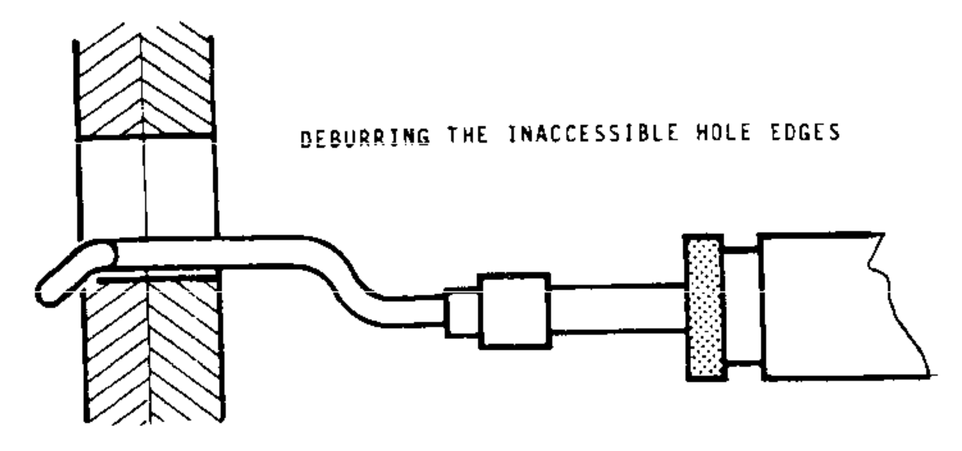


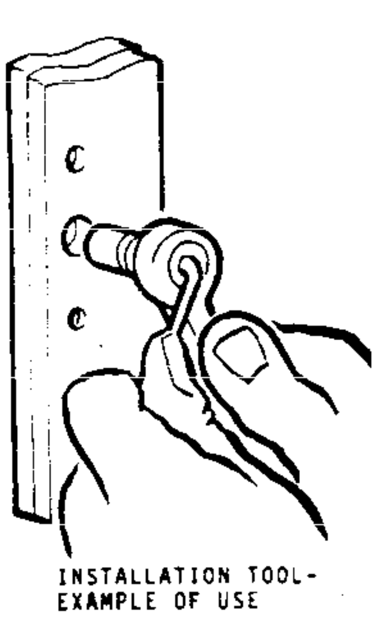
CROSS SECTION A-A
AFTER SB.OL.593-72-108
AND SB.OL.593-14040-150

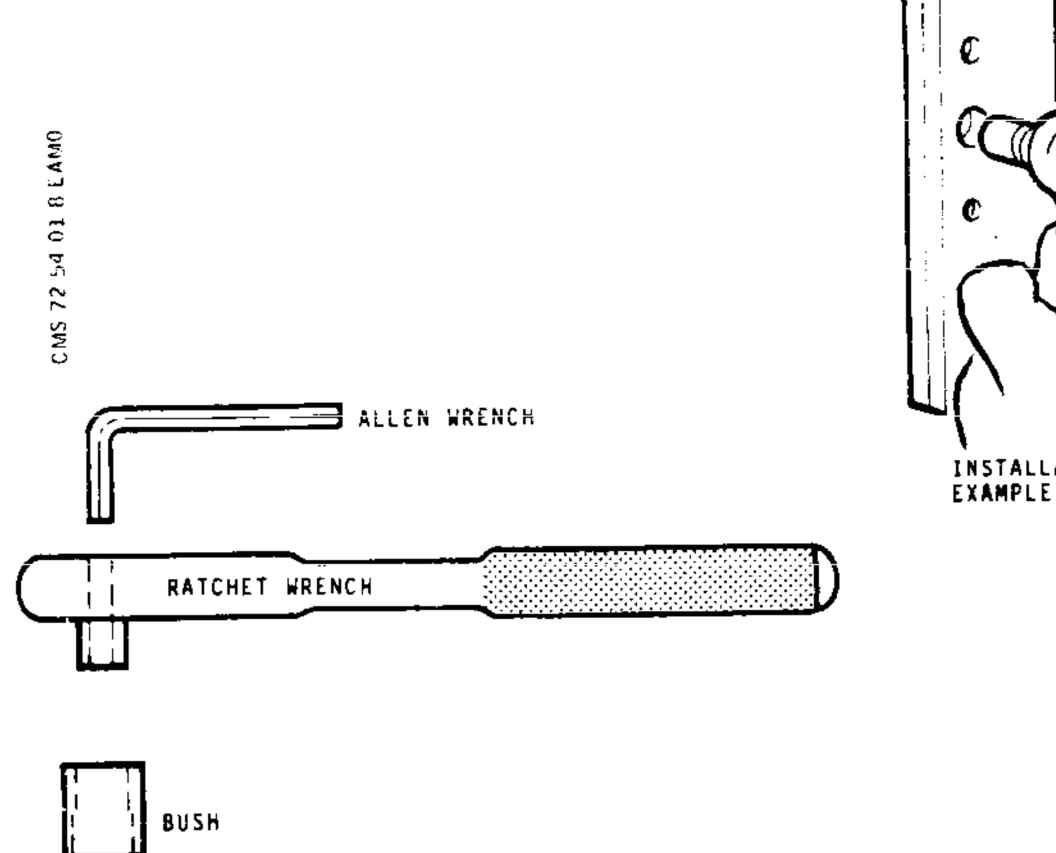


SCREW	MATERIAL	DIAMETER mm (in)	DRILLING DIAMETER mm (in)	NUT
HL 40-5-3	Z6 NCT 25	4,15 (0.1635)	4,17 + 0,1 + 0 (0.168) (0.164)	HL 97-5
HL 40-6-3	Z6 NCT 25	4,81 (0.1895)	4,83 + 0,1 + 0 (0.194) (0.190)	HL 97-6
HL 140-6-3	Z6 NCT 25	5,14 (0.2026)	5,16 + 0,1 + 0 (0.207) (0.203)	HL 197-6

Replacement of Rivets Attaching Sealing Strip
R Section to Spherical Flange, Using "HI-LOK" Screws
R Figure 804 (Sheet 2 of 2)

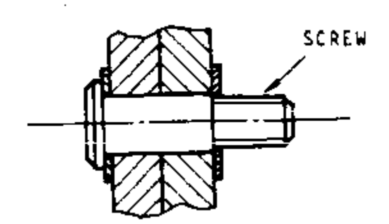




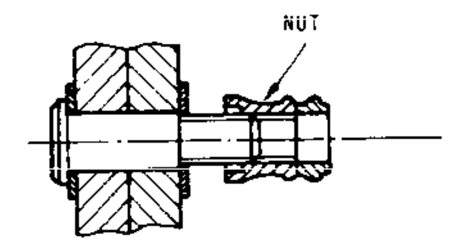


Installation of "HI-LOK" Screws
Figure 805

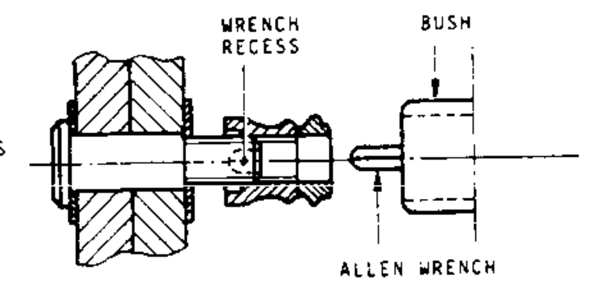
1. LOCATE THE SCREW IN ITS RECESS



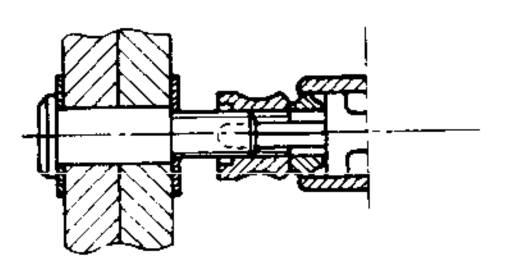
2. ENGAGE THE NUT ON THE SCREW BY TWO THREADS MINIMUM



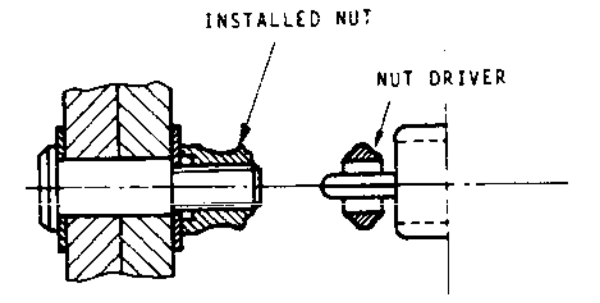
3. ENGAGE ALLEN WRENCH OF INSTALLATION TOOL IN THE SCREW END RECESS



4. BEAR THE INSTALLATION TOOL FIRMLY AGAINST THE NUT AND OPERATE THE DRIVER UNTIL SHEARING OF THE NUT DRIVING COLLAR OCCURS



5. DISENGAGE THE ALLEN WRENCH FROM THE SCREW



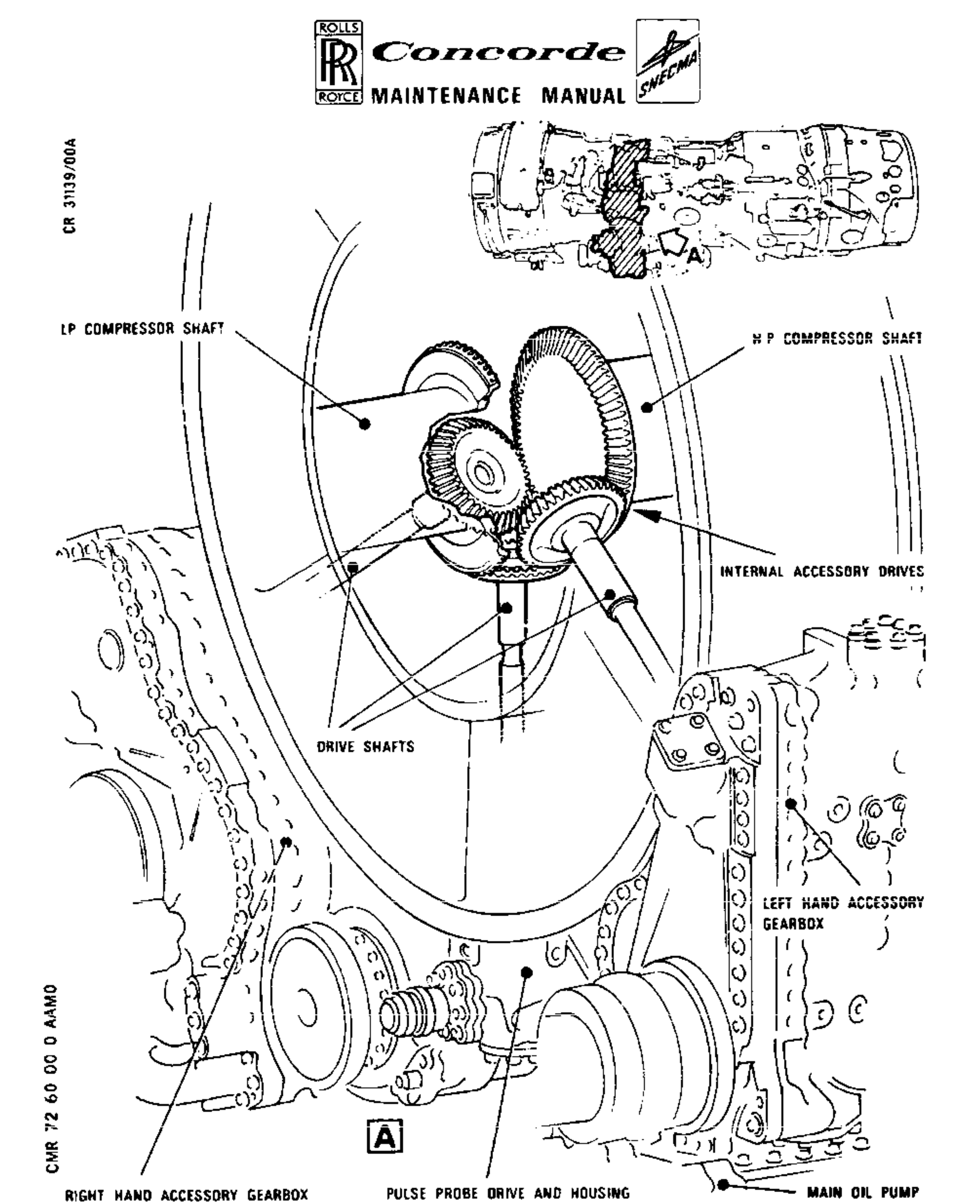
CMS 72 54 01 8 FAMO

Installation of "HI-LOK" Screws
Figure 806

ACCESSORY DRIVES - DESCRIPTION AND OPERATION

1. Description (Ref. Fig. 001)

Bevel gears on the LP and HP compressor shafts transmit the drive for the accessories through shafts to the pulse probe drive and housing and the right-hand and left-hand accessory gearbox assemblies. The drive in the LH gearbox engages with the drive of the main oil pump which is mounted in the gearbox base.



Accessory Drive and Shaft Arrangement.
Figure 001

INTERNAL ACCESSORY DRIVES - DESCRIPTION AND OPERATION

1. General (Ref. Fig. 001)

   Internal accessory drives for the pulse probe drive and housing, and the left-hand and right-hand accessory gearbox assemblies are accommodated in the compressor intermediate case. The pulse probe drive and housing is shaft driven from the LP compressor rotor shaft, whereas the shaft drives for the LH and the RH gearbox assemblies are from the HP compressor rotor shaft.

2. LP Shaft Drive

   A bevel gear, located on the LP rotor shaft rear near the shaft bearing and secured to the shaft by a ringnut, engages the bevel gear for the pulse probe drive shaft.

   The bevel gear for the pulse probe drive is supported by a roller bearing and a ball thrust bearing both accommodated in a housing which is bolted to the compressor intermediate case. The bevel gear is internally splined for engagement with the pulse probe drive shaft.

   An oil sump assembly and tube surrounds the bevel gear and drive to form a scavenge oilway through the compressor intermediate case No. 4 vane.

3. HP Shaft Drive

   The bevel gear on the HP shaft is secured by a ringnut and drives two pinions one for the left-hand, and one for the right-hand gearbox assembly. The pinions and drive shafts for the gearboxes are similar, each pinion is supported by roller and ball thrust bearings accommodated in a housing bolted to the compressor intermediate case. The left-hand pinion has one ball thrust and one roller bearing, whereas the right-hand pinion is supported by one ball thrust and two roller bearings. Each pinion is internally splined to engage with the associated gearbox drive shaft.

   An oil tube surrounds each drive shaft to provide a scavenge oilway within No. 3 and No. 5 compressor intermediate case vane.

CR 31138 00A

RIGHT HAND PINION

HOUSING

DRIVE SHAFT

OIL TUBE

COMPRESSOR INTERMEDIATE CASE

RING NUT

HP COMPRESSOR SHAFT

CMR 72 61 00 0 AAM0

LP COMPRESSOR SHAFT

BEVEL GEAR

LEFT HAND PINION

BEVEL GEAR

HOUSING

BEVEL GEAR

HOUSING

DRIVE SHAFT

OIL TUBE

PULSE PROBE DRIVE

OIL TUBE

FORWARD

Internal Accessory Drives
Figure 001

ACCESSORY GEARBOX ASSEMBLY - LEFT-HAND
DESCRIPTION AND OPERATION

1. General (Ref. Fig.001 and 002)

The left-hand accessory gearbox assembly comprises an accessory gearbox case assembly, which houses the accessory gearbox main drives. These drives are for the first stage fuel pump and idler gear, the fuel control unit and the main oil pump. The main oil pump is accommodated in the base of the accessory gearbox as described in 72-65-00.

The accessory gearbox is attached to the intermediate case at the driving shaft aperture by bolted flanges and supported by brackets bolted to the intermediate case front and rear flanges.

2. Accessory Gearbox Case and Front Cover Assembly

The gearbox case provides the mounting for the fuel control unit, and has the main oil pump bolted to its base. A cover assembly, located by stepped pins and bolted to the front of the gearbox case, incorporates the mounting for the first stage pump.

Passages in the case and cover connect from the main oil feed pump delivery port to oil delivery jets near the drive bearings and gears. Filters are located in the passages to the jets. One oil passage leads to an outlet elbow connection towards the rear of the casing for the bearing oil feed tube connection.

The upper support bracket of a cable guide tube, for the FCU assembly lifting equipment, is attached with gearbox cover bolts to the gearbox case. This guide tube is used in conjunction with lifting equipment for fuel control unit removal and installation.

3. Accessory Gearbox Main Drives

A driving shaft, with external splines at each end, is housed in No. 5 vane of the compressor intermediate case. The upper end of the shaft engages with the pinion in the intermediate case, and its lower end with an internally splined spiral bevel pinion housed in the gearbox case. The spiral bevel pinion is supported by an integral bearing which is bolted to the gearbox case and incorporates ball and roller journal bearings. The pinion is secured in the bearing by a nut.

CR 30746/00A

INTERMEDIATE CASING

BRACKET

COVER ASSEMBLY

ACCESSORY GEARBOX CASE

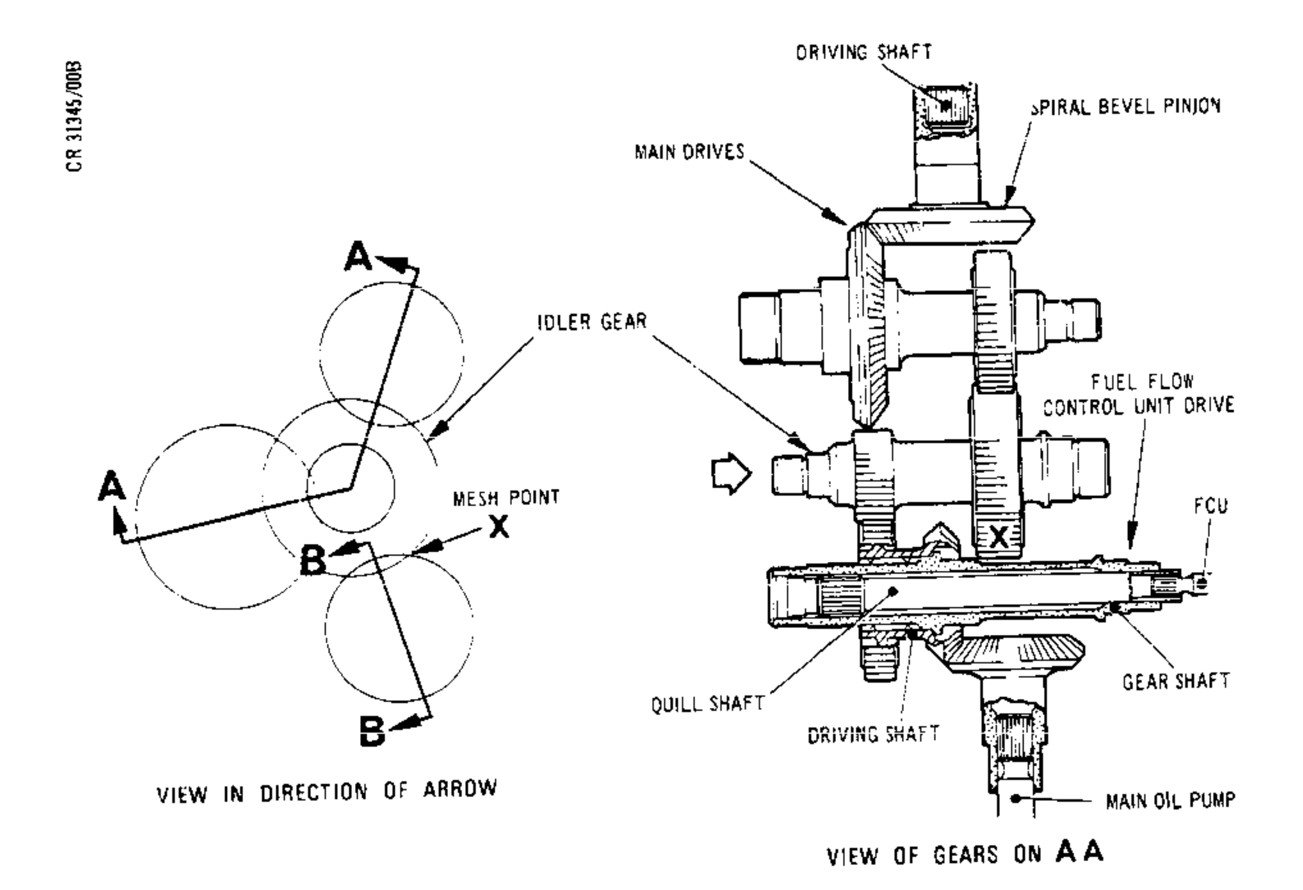
FIRST STAGE PUMP MOUNTING

FUEL CONTROL UNIT MOUNTING

MAIN OIL PUMP

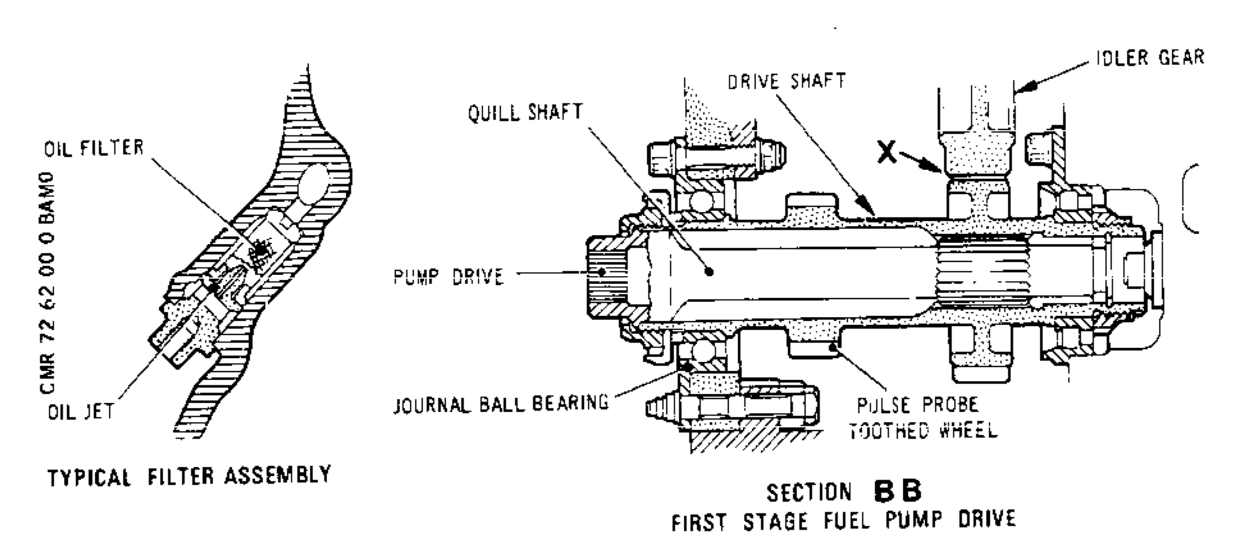
CMR 72 62 00 0 AAMO

Gearbox External Details
Figure 001



VIEW IN DIRECTION OF ARROW

VIEW OF GEARS ON AA



TYPICAL FILTER ASSEMBLY

SECTION BB
FIRST STAGE FUEL PUMP DRIVE

Gearbox - Drive Arrangement and Filters
Figure 002

The spiral bevel pinion engages with a bevel gear assembly and idler gear which is supported by two journal bearings, one ball and one parallel roller, bolted to the gearbox case. The assembly is positioned by a locating sleeve and adjusting washer and secured to the journal bearings by a nut at each end.

R 4. Idler Gear

The idler gear has two gears integral with a shaft supported by two parallel roller journal bearings bolted to the gear-box case. The shaft is secured in the bearing by a nut at each end. Two drives are taken from the idler gear, one from each spur gear. The larger, driven spur gear transmits the drive to the spur gear of the first stage fuel pump
R drive and the smaller gear drives the fuel flow control unit drive.

R 5. First Stage Fuel Pump Drive

R The first stage fuel pump drive consists of a gearshaft
R supported by a ball bearing and a parallel roller bearing
R that are bolted to the gearbox case at each end respect-
R ively. The shaft is retained in the bearings by a nut at
R each end. A spur gear and a toothed wheel are formed
R integral with the shaft. The spur gear is in mesh with the
R idler gear and driven by it while the toothed wheel rotates
R in close proximity to the pole pieces of the HP shaft pulse
R probe to generate a signal as described in 76-12-00. A
R quillshaft is located in the bore of the drive shaft and held
R in splined engagement by a retaining ring. The quillshaft is
R internally splined at its open end to accommodate the fuel
R pump drive shaft.

R 6. Fuel Flow Control Unit Drive and Main Oil Pump Drive

R The fuel flow control unit drive comprises an internally splined driving shaft, a gearshaft with internal and external splines, and an externally splined quillshaft. The three shafts are splined together co-axially as shown in figure 2. The driving shaft has two integral gears, a spur gear receiving the drive from the idler gear, and a bevel gear in engagement with the oil pump drive bevel gear. The drive assembly is supported on journal bearings bolted to the gearbox case and is attached to the bearings by a locking sleeve, adjusting washer, and a nut at each end.

The quillshaft, located in splined engagement in the bore of the gearshaft, incorporates oil feed and oil trap sleeves, the whole assembly being held in position by a retaining ring. In conjunction with oil jets the sleeves provide for

spline lubrication.

The oil pump drive is supported by an integral bearing, which, together with a spacer sleeve, is bolted to the underside of the gearbox case. The drive is positioned by an adjusting washer and secured in the bearing by a round nut.

R ## ACCESSORY GEARBOX ASSEMBLY-LEFT-HAND - REMOVAL/INSTALLATION

1. General

The following removal and installation procedures are applicable to QAD coupling items mounted on the left-hand gearbox. Paragraph 2 applies to the coupling at the first stage fuel pump location and paragraph 3 applies to the coupling at the FCU location.

Specifications for lubricants referred to in the procedure are contained in 70-00-01, Servicing and Storage Materials.

R 2. QAD Coupling at First Stage Fuel Pump Location -
R Removal and Installation (Ref. Fig. 401)

A. Prepare to Remove Coupling.

(1) Remove first stage fuel pump as detailed in 73-11-01, Removal/Installation.

B. Remove Coupling.

(1) Remove sixteen bolts securing the coupling flange to the gearbox.

(2) Withdraw the flange and coupling ring over the two pins located in the gearbox face, then detach and remove the gasket.

(3) Remove bolts, nuts and plate washer securing retaining bracket to gearbox and remove the bracket.

C. Install Coupling.

(1) Assemble gasket over the pins protruding from the gearbox and locate the gasket on gearbox face.

(2) Assemble coupling ring assembly to coupling flange. Hold the coupling ring with its threads uppermost, then place the coupling flange (grooved face up) in the ring.

(3) Assemble the coupling flange and ring to the gearbox and secure with seven short bolts and nine long bolts with lubricant A applied. Torque-tighten the bolts to 100 lbf in. (11,3 N.m).

(4) Apply lubricant A to the retaining bracket bolts, assemble the bolts to the bracket then locate the bracket on the gearbox. Secure bracket with the

CR 34274/00A

A

LH GEARBOX

DIAGRAMMATIC VIEW IN DIRECTION OF ARROW B
SHOWING LOCATION OF LONG AND SHORT BOLTS

COUPLING RING

GASKET

B

COUPLING FLANGE

RETAINING BRACKET

A

PLATE WASHER

CMR 72 62 00 4 AAMO

Detail of QAD Coupling at First Stage
Pump Location
Figure 401

plate washer and nuts torque-tightened to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

D. Complete the Installation.

(1) Install the first stage fuel pump as detailed in 73-11-01.

R 3. QAD Coupling at FCU Location - Removal and Installation (Ref. Fig. 402)

A. Prepare to Remove Coupling.

(1) Remove FCU as detailed in 73-21-01, Removal/ Installation.

B. Remove Coupling.

(1) Remove sixteen bolts securing the coupling flange to the gearbox.

(2) Withdraw the flange and coupling ring over the two pins located in the gearbox face, then detach and remove the gasket.

(3) Remove bolts, nuts and brackets (or plate washer if engine is to SB.OL593-72-131 standard) securing the retaining bracket to the gearbox. Remove retaining bracket and withdraw the hollow pins from bolt locations.

C. Install Coupling.

(1) Assemble gasket over the pins protruding from the gearbox and locate the gasket on gearbox face.

(2) Assemble coupling ring assembly to coupling flange. Hold the coupling ring with its thread uppermost, then place the coupling flange (grooved face up) in the ring.

(3) Assemble the coupling ring and flange to the gearbox, then secure the flange with 16 bolts with lubricant A applied. Torque-tighten the bolts to 100 lbf in. (11,3 N.m).

(4) Assemble hollow pins to the bolt locations of the retaining bracket, locate the bracket on the under-side of the mounting flange and insert two bolts through the bracket and flange. Apply lubricant A to the bolts, then secure the bracket with the

CR 34275/00A

A

PLATE WASHER
(SB.72-131)

BRACKET
(PRE-SB.72-131)

RETAINING BRACKET

A

HOLLOW PIN

GASKET

COUPLING RING

COUPLING FLANGE

CMR 72 62 00 4 BAMO

Detail of QAD Coupling at FCU Location
Figure 402

plate washer (SB.OL.593-72-131 standard) or bracket (pre SB.OL.593-72-131 standard) and nuts. Torque-tighten the nuts to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

D. Complete the Installation.

(1) Install the FCU as detailed in 73-21-01.

FLOW CONTROL UNIT AND MAIN OIL PUMP DRIVES - REMOVAL/INSTALLATION

1. General

If the main oil pump drive shaft shears, the broken part can easily be withdrawn from the oil pump drive bevel gear and the oil pump renewed (Ref.72-65-00, Removal/Installation). If the fuel flow control unit (FCU) drive shaft shears, the broken end can move into the bore of the driving quillshaft in the left-hand gearbox and make extraction difficult. The following procedure covers the removal of the broken shaft from the gearbox, in the event of a failure, and the installation of a new drive shaft.

2. Tools

Magnet Assembly S3S12643000

3. FCU Drive Shaft (Ref. Fig. 401)

A. Prepare to Remove Broken Drive Shaft.

(1) Open engine bay doors on engines No.1 and No.3 and engine bay lower doors on engines No.2 and No.4 (Ref.71-00-00, Servicing).

(2) Electrically isolate the engine additional services and remove the FCU (Ref.73-21-01, Removal/ Installation).

B. Remove Broken Drive Shaft.

(1) Ensure cleanliness of splines, then insert the magnet assembly S3S12643000 into the bore of the FCU driving quillshaft in the left-hand gearbox as shown in (Ref. Fig. 401).

(2) Probe with the magnet assembly until the broken end of the FCU drive shaft is attracted to the magnet, then withdraw the tool and the broken drive shaft from the gearbox.

NOTE: Some careful manipulation of the magnet assembly may be necessary, to align the broken drive shaft splines with those of the driving quillshaft, during withdrawal.

C. Prepare to Install New FCU.

(1) Clean the area inside the gearbox aperture.

LEFT-HAND GEARBOX

A

FCU MOUNTING

FCU DRIVING QUILLSHAFT

CR 33882/00A

A

BROKEN END OF
FCU DRIVE SHAFT

MAGNET ASSEMBLY

FCU DRIVING QUILLSHAFT

PART SECTION THROUGH
LEFT-HAND GEARBOX SHOWING
FCU DRIVE

CMR 72 62 04 4 AAMD

FCU Drive - Removing Broken Drive Shaft
Figure 401

(a) Wipe over the affected area with a clean cloth, ensuring that any metal particles are removed.

(2) Check the left-hand gearbox oil system for contamination.

(a) Remove and inspect the left-hand gearbox scavenge filter (Ref.72-01-00, Servicing and Inspection/Check).

(b) Install the scavenge filter (Ref.72-01-00, Servicing).

D. Complete the Installation.

R (1) Lubricate the toroidal sealing ring (Ref. 70-00-03)
R for the QAD coupling and install new FCU (Ref.73-21-01, Removal/Installation).

<u>NOTE:</u> The drive shaft is an integrated part of the FCU.

(2) Replenish the oil system (Ref.12-13-79).

(3) Remove safety clips and reset circuit breakers (Ref.73-21-01, Removal/Installation).

(4) Close engine bay doors and carry out checks specified for FCU (Ref. 71-00-00, Servicing and Adjustment/Test).

ACCESSORY GEARBOX ASSEMBLY - RIGHT-HAND
DESCRIPTION AND OPERATION

1. General

The right-hand accessory gearbox assembly comprises an accessory gearbox case assembly which houses the accessory gearbox main drives. These drives are for the air starter and integrated drive generator (IDG) unit, the scavenge oil pump and idler shaft, and the main and stand-by hydraulic pumps.

2. Accessory Gearbox Case Assembly (Ref.Fig.1)

The accessory gearbox case assembly is attached to the inter-
R mediate case at the driving shaft aperture by a bolted flange The assembly provides mountings for the IDG and the main and stand-by hydraulic pumps.

A cover assembly, located by dowels and bolted to the front of the gearbox case, incorporates a mount for the air starter. A blank cover seals an aperture and mounting face that are provided for the installation of engine turning equipment. A pressure oil feed tube connects to an inlet on the cover that interconnects with passages in the cover and gearbox case.

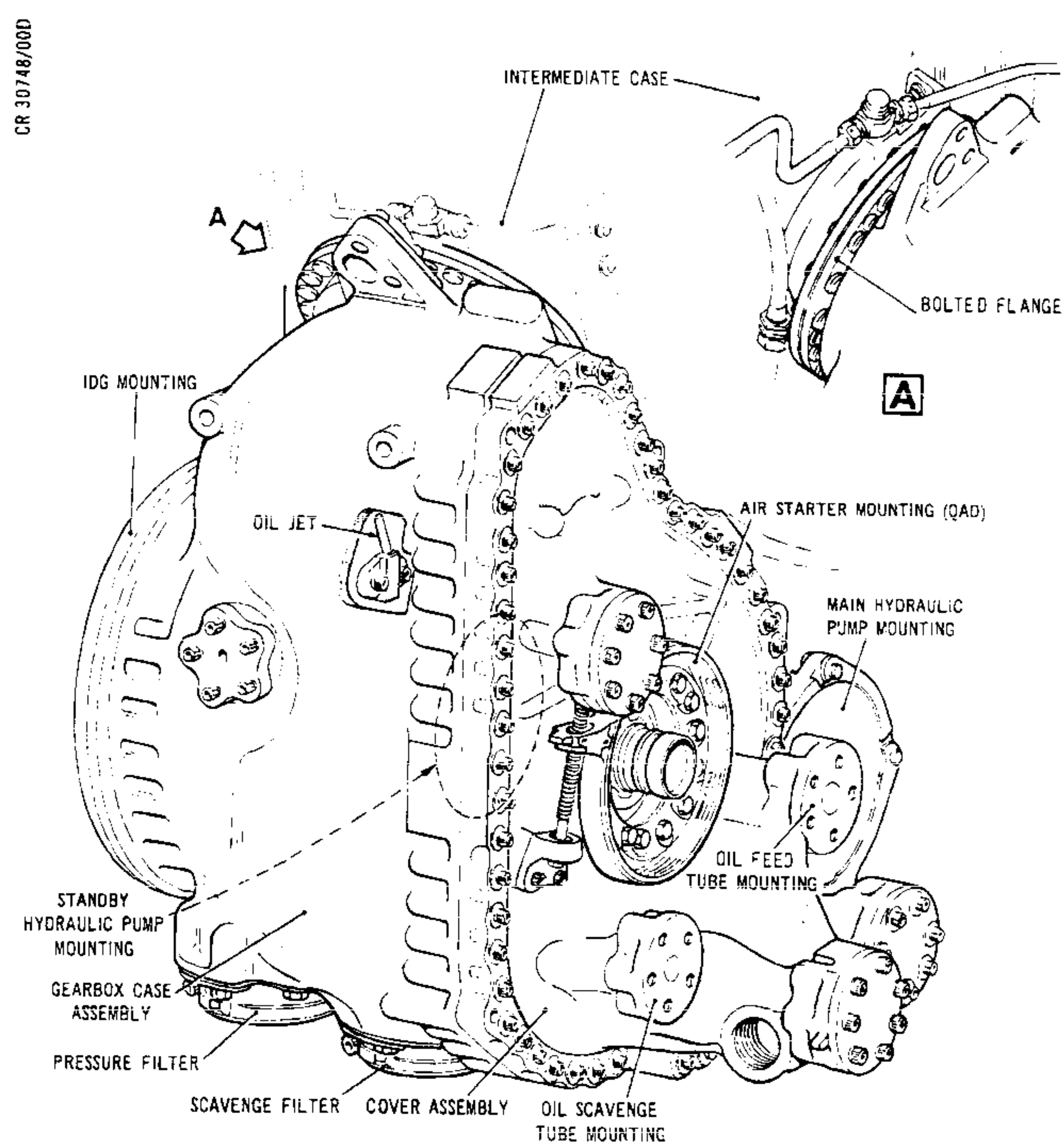
A pressure filter and scavenge filter are housed in the bottom of the gearbox case and are retained by quick attach/detach (QAD) couplings. Each filter assembly is held loosely captive on its cover assembly by a ring of threads. A spring, located between the cover and filter end, ensures location of filter without crushing. A restrictor plug is located at the inner end of the pressure filter housing. The cover of the scavenge filter incorporates a magnetic plug and drain valve assembly. A scavenge pump is located near the scavenge filter.

Internal passages in the case and cover incorporate filters and delivery jets near the drives and bearings and also lead from the base of the gear chamber, via the scavenge filter and scavenge pump to an outlet connection for the return oil system tube.

3. Main Drives (Ref.Fig.2)

The main drives of the gearbox consist of a flexible coupling shaft, a spiral bevel gear wheel and a spur gear driver and bevel gear assembly.

R
R
R
R
R
R
R
R
R
R
R
R
R
R



Gearbox External Detail
Figure 001

coupling shaft, a spiral bevel gear wheel and a spur gear driver and bevel gear assembly.

The flexible coupling shaft, externally splined at each end, is housed in No. 3 vane of the compressor intermediate case. The upper end of the shaft engages with the right-hand pinion of the internal accessory drives and the lower end engages with the spiral bevel wheel gear assembly in the gearbox case. The spiral bevel wheel is supported by ball and roller journal bearings bolted to the gearbox case. A spacer sleeve and adjusting washers position the wheel in the bearing assembly in which it is retained by a round nut. The spiral bevel gear of the coupling shaft engages the bevel gear of the spur gear driver and bevel gear assembly.

The spur gear driver is supported by ball and roller journal bearings bolted to the gearbox case and front cover and is positioned by an adjusting plate and adjusting washer. The bevel gear is splined to the spur gear driver shaft where it is positioned between the bearing and a shoulder on the shaft by an adjusting washer.

4. Air Starter and Integrated Drive Generator (IDG) Drives

Two spur gears are formed integral with a shaft that is supported at one end by a roller journal bearing, bolted to the gearbox front cover, and at the other end by a ball journal bearing. The ball journal bearing, together with an oil meter plate, oil housing, key ring and sealing rings, is bolted to the gearbox case. The assembly is retained to the journal bearing, by round nuts. The larger of the spur gears is in mesh with the main drives and the smaller gear transmits a drive to the scavenge pump and idler drive as shown.

The shaft of the assembly is internally splined at each end. One end is splined to receive the air starter shaft and the other, for the IDG drive, engages with a splined shaft extension that is retained in engagement by a sleeve retainer and bolt.

5. Scavenge Oil Pump and Idler Shaft Drives

Two spur gears, formed integral with internal splines, engage the splines of the idler shaft. Two roller bearings, bolted to the gearbox case, support the shaft that is retained in the bearings by a nut. The larger of the two spur gears is in engagement with the air starter and IDG drive and the hydraulic pump drive as shown. The

CR 31325 '00A

JOURNAL BEARINGS
GEAR
A
TYPICAL GEAR AND BEARING ASSEMBLY

FLEXIBLE COUPLING SHAFT
SPIRAL BEVEL GEAR
MAIN DRIVES
BEVEL GEAR
SPUR GEAR DRIVER
AIR STARTER
IDG SHAFT EXTENSION
AIR STARTER AND IDG DRIVES
FORWARD
IDLER SHAFT
SCAVENGE OIL PUMP
HYDRAULIC PUMP DRIVE
MAIN PUMP
STANDBY PUMP
GEARBOX DRIVES ARRANGEMENT

JET
FILTER
A
TYPICAL FILTER AND DELIVERY JET

CMR 72 63 00 0 BAMO

Gearbox Drive Arrangement
Figure 002

CR 31346 00A

FORWARD

O A D RING

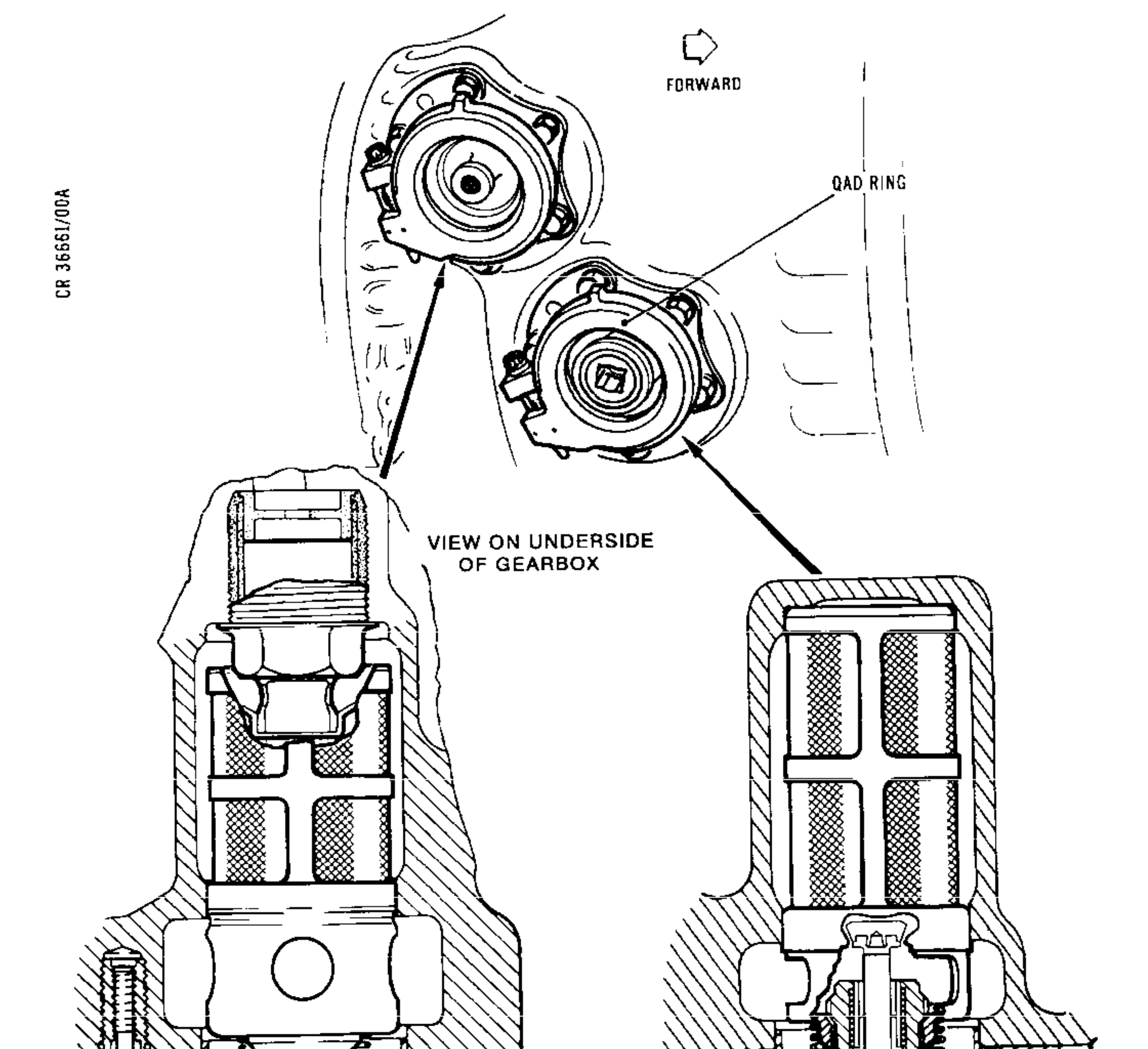
VIEW ON UNDERSIDE OF GEARBOX

CMR 72 63 00 0 CAMO

PRESSURE FILTER ASSEMBLY

SCAVENGE FILTER ASSEMBLY

Gearbox Filters
R (Pre SB.OL.593-72-9036-419)
Figure 003



R Gearbox Filters
R (SB.OL.593-72-9036-419)
R Figure 004

smaller gear is in mesh with the scavenge oil pump spur gear that transmits the drive to the pump. The pump spur gear is supported by a spacer sleeve and parallel roller journal bearing bolted to the gearbox case and is retained to the bearing by a plate washer and nut.

6. Main and Stand-by Hydraulic Pump Drives

A spur gear shaft, internally splined at each end to take the pump quill shafts, meshes with the idler gear. The shaft is supported by ball and parallel roller journal bearings bolted to the gearbox case. The shaft, together with seals is positioned by an adjusting washer and retained with round nuts.

ACCESSORY GEARBOX ASSEMBLY RH - SERVICING

1. General

The procedure applicable to the pressure and scavenge filters of the right-hand gearbox is contained in 72-01-00, Servicing.

ACCESSORY GEARBOX ASSEMBLY - RIGHT-HAND - REMOVAL/INSTALLATION

1. General

The following removal and installation procedures are applicable to QAD coupling items mounted on the right-hand gearbox at the air starter location (Ref.para.2) and the IDG location (Ref. para.3) and the oil scavenge and oil pressure filter locations (Ref. para.4).

Should an oil leak occur at the QAD coupling between the right-hand gearbox and the intermediate casing, it may be rectified by compliance with the slackening/re-tightening procedure detailed in paragraph 5.

The procedures of paragraphs 4.B. and 4.C. apply to both pre and S.B.OL.593-72-7 standard of adapter and pre and S.B.OL.593-72-8312-189 standard of sealing ring at either filter location.

Details of approved servicing and storage materials quoted in this chapter are given in 70-00-01.

2. QAD Coupling at Air Starter Location - Removal and Installation (Ref. Fig. 401)

A. Prepare to Remove Coupling.

(1) Remove air starter from engine (Ref.80-11-11).

B. Remove Coupling.

(1) Remove 13 bolts securing the plain flange and coupling ring assembly to the gearbox, detach the flanged pins from the plain flange, then remove the flange, coupling ring assembly and gasket from the gearbox. Separate the flange from the coupling ring.

(2) Remove two bolts securing the mounting bracket to the gearbox and withdraw the bracket from its location

C. Install Coupling

(1) Assemble coupling ring to plain flange.

(a) Hold the coupling ring assembly with its threads uppermost, then place the flange (bolthead locations facing up) in the coupling ring.

(2) Assemble plain flange and coupling ring to gearbox.

(a) Apply lubricant A to attachment bolts.

(b) With a gasket interposed between the gearbox face and plain flange, hold the plain flange and coupling ring in position with bolt-holes aligned, then insert the three flanged pins into their locations and retain them with bolts lightly tightened.

(c) Assemble remaining bolts to the flange then torque-tighten all bolts to 100 lbf in. (11,3 N.m).

(3) Assemble the mounting bracket to its location and secure it with two bolts with lubricant A applied.

Torque-tighten the bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

D. Complete the Installation

(1) Install the air starter (Ref. 80-11-11).

3. QAD Coupling at IDG Location - Removal and Installation (Ref. Fig. 402)

A. Prepare to Remove QAD Coupling.

(1) Remove IDG from engine (Ref. 24-11-11).

B. Remove Coupling.

(1) Remove 32 bolts securing plain flange and coupling ring assembly to gearbox, withdraw the hollow pins from the flange, then remove the flange, coupling ring and gasket from the gearbox. Separate the flange from the coupling ring.

(2) Remove nuts, bolts and load spreading washers securing mounting bracket to gearbox and withdraw the bracket from its location.

C. Install Coupling.

(1) Assemble coupling ring to plain flange.

(a) Hold the coupling ring assembly with its

CR 34368/ODA

FORWARD

A

GASKET

COUPLING RING

FLANGED PIN

A

CMR 72 63 00 4 AAM0

RIGHT-HAND GEARBOX

MOUNTING BRACKET

PLAIN FLANGE

Detail of QAD Coupling at Air Starter Location
Figure 401

threads uppermost then place the plain flange (seal location facing up) in the coupling ring. If difficulty is experienced in assembling the flange to the ring, refer to SB.OL.593-72-118.

(2) Assemble plain flange and coupling ring to gearbox.

(a) Apply lubricant A to attachment bolts.

(b) With a gasket interposed between the gearbox face and the plain flange, hold the plain flange and coupling ring in position with bolt-holes aligned, then insert the three hollow pins into the flange and retain them with bolts lightly tightened.

(c) Assemble remaining bolts to the flange and torque-tighten all bolts to 100 lbf in. (11,3 N.m).

(3) Assemble mounting bracket to its location.

(a) Dispose the coupling ring assembly to position its locking trunnion between the gearbox mounting bracket and the QAD coupling mounting bracket location.

(b) Assemble the mounting bracket to its location and align bolt-holes.

(c) Secure the mounting bracket, together with the IDG oil tubes support bracket, with two load spreading washers positioned as shown, bolts and nuts with lubricant A applied.

(d) Torque-tighten the nuts to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

D. Complete the Procedure.

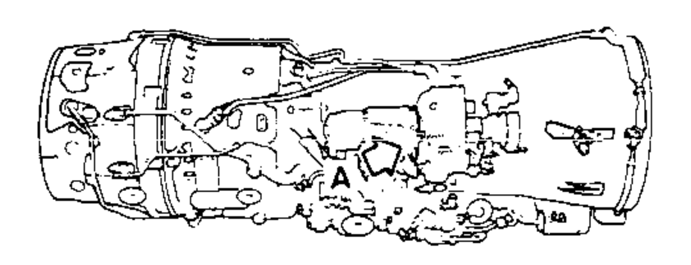
R (1) Lubricate the toroidal sealing ring (Ref. 70-00-03)
R for the QAD coupling and install the IDG (Ref.24-11-11).

4. QAD Coupling at Oil Scavenge and Pressure Filter Locations - Removal and Installation

A. Prepare for Removal of QAD Coupling.

(1) Open engine bay front lower door (Ref. 71-00-00, Servicing).

CR 34367/00A



LOAD SPREADING WASHER

IDG OIL TUBES SUPPORT BRACKET

B

COUPLING RING

GASKET

HOLLOW PIN

B

PLAIN FLANGE

A

MOUNTING BRACKET

RIGHT-HAND GEARBOX

CMR 72 63 00 4 BAMO

Detail of QAD Coupling at IDG Location
Figure 402

(2) Remove filter from gearbox.

(a) Clean the area surrounding the location of the filter to be removed.

(b) Drain oil from the right-hand gearbox and remove the filter as detailed in 72-01-00, Servicing.

B. Remove QAD Coupling Adapter (Ref. Fig. 403)

(1) Remove bolts securing the bracket to the adapter flange and detach the bracket.

(2) Remove remaining bolts from the adapter flange and remove adapter from gearbox.

(3) If a replacement adapter is to be installed, carefully drive the shouldered pin and the stepped pin from the removed adapter and retain them for installation in the replacement adapter.

C. Install QAD Coupling Adapter (Ref. Fig. 403)

(1) Assemble pins to replacement adapter.

(a) Carefully press the shouldered pin, chamfered edge leading, into the underside of the adapter at the position shown and ensure that the pin shoulder is flush with the adapter face.

(b) Carefully press the stepped pin, chamfered edge leading, into its location on the underside of the adapter and ensure that the base of the pin is flush with the adapter face.

(c) Check that both pins are secure in their locations.

(2) Assemble a serviceable sealing ring (Ref.70-00-03, Sealing Devices), in accordance with the Service Bulletin standard as follows:

CAUTION: DO NOT INSTALL CORRUPLUS SEAL IN ADAPTER TO PRE S.B. OL.593-72-7 STANDARD.

(a) Adapter to pre S.B. OL.593-72-7 standard - assemble toroidal sealing ring to S.B. O.L.593-72-8312-189 to adapter mounting face groove.

C.R 34396/00A

A

TOROIDAL SEALING RING (SB.72-8312-189)

PRESSURE FILTER LOCATION

CORRUPLUS SEAL (PRE SB.72-8312-189)

ADAPTER

SHOULDERED PIN

STEPPED PIN

BRACKET

SCAVENGE FILTER LOCATION

A

CMR 72 63 00 4 CAM0

QAD Coupling Adapter
Figure 403

(b) Adapter of S.B.72-7 standard - assemble either a Corruplus seal or a toroidal sealing ring (Ref. S.B. OL.593-72-8312-189) to adapter mounting face.

(3) Secure adapter to gearbox.

(a) Apply lubricant A to attachment bolts.

(b) With the seal in position, hold the adapter on the gearbox with the shouldered pin engaged in its locating hole.

(c) Retain the adapter with two bolts clear of the bracket location and lightly tighten the bolts.

(d) Assemble the bracket to the adapter and screw the remaining bolts into their locations.

(e) Torque-tighten all bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

D. Complete the Installation.

(1) Install the oil scavenge filter and/or oil pressure filter in the gearbox and add oil to the tank as detailed in 72-01-00, Servicing.

(2) Close engine bay door (Ref.71-00-00, Servicing).

R

AIR STARTER DRIVE AND INTEGRATED DRIVE GENERATOR (IDG) DRIVE - REMOVAL/INSTALLATION

1. General

   The following procedures cover the removal and installation of the integrated drive generator (IDG) splined shaft following a failure of the shaft.

2. Integrated Drive Generator (IDG) Splined Shaft (Ref. Fig. 401)

   A. Prepare the Gearbox for IDG Splined Shaft Renewal.

      (1) Open engine bay doors (Ref. 71-00-00, Removal/ Installation).

      (2) Remove the IDG.

         (a) Observe the safety precautions and remove the IDG (Ref.24-00-00, General - Removal/ Installation, 24-11-11, Removal/Installation).

   B. Remove the Splined Shaft.

      (1) Remove the splined shaft retaining bolt and sleeve securing the splined shaft to its location in the end of the starter/IDG spur gear drive.

         (a) Unscrew and remove the retaining bolt and sleeve. Should the gearbox rotate during this action, immobilize the engine with the hand turning gear (Ref. 72-09-01).

         (b) Withdraw the broken end of the splined shaft from the spur gear drive.

   C. Prepare to Install New Splined Shaft.

      (1) Clean the area inside the gearbox aperture.

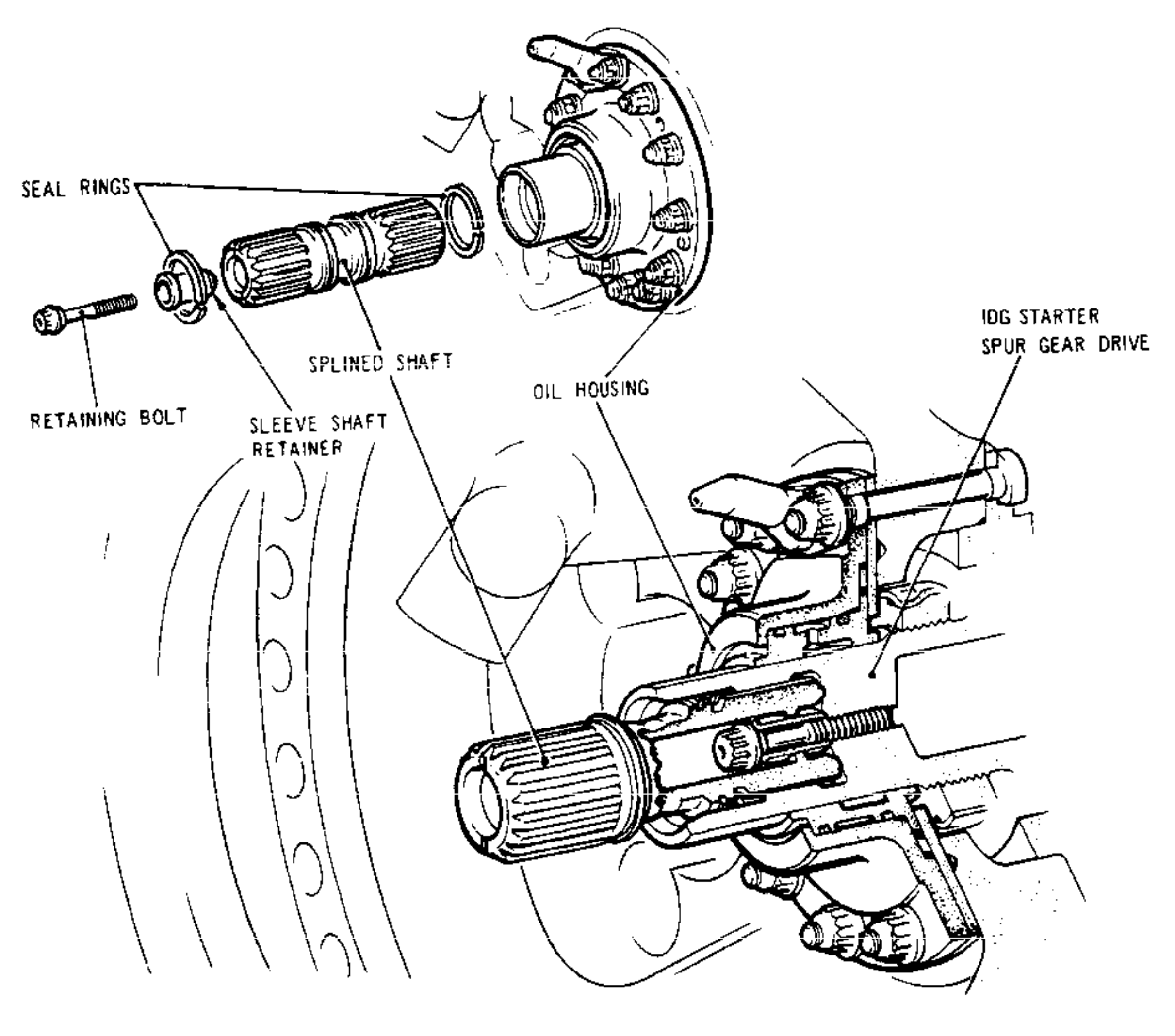
         (a) Wipe over the affected area with a clean cloth, ensuring that any metal particles are removed.

      (2) Check the right-hand gearbox oil system for contamination.

         (a) Remove and inspect the magnetic plug (Ref. 72-01-00, Servicing and Inspection/Check).

         (b) Remove and inspect the scavenge filter (Ref. 72-01-00, Servicing and Inspection/Check).

CR 33542/00A



CMR 72 63 03 4 AAMO

Attachment Details of IDG Splined Shaft Assembly
Figure 401

(c) Install the scavenge filter and the magnetic plug (Ref. 72-01-00, Servicing).

(3) Assemble the two seal rings into the grooves on the new splined shaft.

D. Install the New Splined Shaft.

(1) Insert the splined shaft and seal rings assembly into the splined bore of the IDG drive shaft, ensuring that the end of the splined shaft with the reduced internal diameter enters first (Ref. Fig. 401).

(2) With lubricant A applied, assemble the retaining sleeve into the splined shaft and retain the sleeve and the splined shaft to the spur gear drive assembly with the bolt.

(3) Torque-tighten the bolt between 67 and 73 lbf in. (7,6 and 8,2 N.m).

E. Complete the Installation.

(1) Install the IDG.

(a) Observe the safety precautions, install the IDG and carry out the required checks (Ref. 24-00-00, General - Removal/Installation, 24-11-11, Removal/Installation and Adjustment/Test).

(2) Replenish engine oil tank to correct level (Ref. 12-13-79).

(3) Close engine bay doors (Ref. 71-00-00, Removal/Installation).

MAIN AND STAND-BY HYDRAULIC PUMP DRIVES - REMOVAL/INSTALLATION

1. General

R The procedures given in this chapter apply to engines to both pre and S.B.OL.593-72-8510-171 standard and cover the removal and installation of the two Sealol oil seals in the right-hand gearbox. The seals are situated one on each side of the hydraulic pumps driving spur gearshaft. The removal and installation procedure for the seal located on the main hydraulic pump drive side of the spur gearshaft is given in paragraph 4 and the procedures for the seal located on the stand-by hydraulic pump drive side of the spur gearshaft are given in paragraph 5. Combine the procedures if both seals are to be renewed.

2. Tools

Gear replacement tool set (1)	PE.34610
Gear replacement tool set (2)	PE.34637
Extractor (3 off)	PE.29828
Torque wrench (torque)	T2EM1992
Torque wrench (de-torque)...	T2EM1994
Torque box assembly...	PE.35775
Press pad (seal removal)	S3S11734000
Support (seal removal)	S3S11735000
Press pad (seal assembly)...	S3S10637000
Support (seal assembly)	S3S10638000
Spanner...	S3S10652000

3. Prepare Gearbox for Hydraulic Pump Drive Oil Seal Renewal

A. Open engine bay front doors (Ref. 71-00-00, Servicing).

B. Remove Main Hydraulic Pump.

(1) Observe the safety precautions and remove the pump (Ref. 29-00-00, General - Removal/Installation, 29-11-71 or 29-12-71, Removal/Installation).

C. Remove Stand-by Hydraulic Pump or Blank Assembly.

(1) If hydraulic pump installed - observe the safety precautions and remove pump (Ref.29-00-00, General - Removal/Installation, 29-11-71 or 29-12-71, Removal/Installation).
(Sheet 1 of 2)
(Sheet 2 of 2)

(2) If blank assembly installed, remove as follows:

CR 33553/00B

TORQUE WRENCH

A

B

SPLINED SHAFT

TORQUE BOX

REACTOR PLATE

BUSHING ADAPTER

MAIN HYDRAULIC PUMP ADAPTER

RETAINING RING

NUT

KEY WASHER

CORRUPLUS SEAL

ADJUSTING WASHER

SEALOL SEAL

SLEEVE SEAL

SEAL MATING RING

IMMOBILIZER

MAIN HYDRAULIC PUMP ADAPTER

CMR 72 63 05 4 AAMA

Disassembly and Assembly Details of Hydraulic Pump Drive Sealol Seals!
Figure 401

R

CR 33570/00B

IMMOBILIZER

STAND-BY HYDRAULIC PUMP ADAPTER

C

BRACKET LOCATION

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

IMMOBILIZER LOCATION

E

D

DRAIN ELBOW LOCATION

STAND-BY HYDRAULIC PUMP ADAPTER

GEARBOX CASE

FLANGED BALL BEARING

IMMOBILIZER

GEAR

STAND-BY HYDRAULIC PUMP ADAPTER ASSEMBLY

SLEEVE SEAL

SEAL MATING RING

SEALOL SEAL

CORRUPLUS SEAL

ADAPTER

KEYWASHER

NUT

RETAINING RING

B

CMR 72 63 05 4 AAMB

Disassembly and Assembly Details of
Hydraulic Pump Drive Sealol Seals!
Figure 401

R

EFFECTIVITY: ALL

BA

(a) Disconnect the electrical connector from the parking bracket.

(b) Remove the self-locking nuts, lock and spherical washers from the inner and outer eye-bolts of the rim clenching clamp assembly securing the pump blank assembly to the adapter.

(c) Remove the clamp and blank assembly from the adapter.

NOTE: To facilitate assembly, temporarily replace the nuts and washers on their respective eye-bolts.

D. Remove the Hydraulic Pumps Oil Drain Tube.

(1) Remove the two bolts which secure the drain tube to the main hydraulic pump adapter.

(2) Remove the bolt and detach the tube clamp assembly from the bottom of the right-hand gearbox.

(3) Disconnect the tube at the stand-by hydraulic pump adapter and at the connection next to the clamp assembly.

(4) Remove the drain tube and, on S.B.OL.593-79-3 standard engines, remove and discard the gasket from the main hydraulic pump adapter connection.

4. Renew Oil Seal for Main Hydraulic Pump Drive (Ref. Fig. 401)

A. Remove Main Pump Adapter from Gearbox.

(1) Comply with the preparation procedures (Ref.para.3).

(2) Immobilize the hydraulic pump drive spur gearshaft (Ref. Fig. 401).

(a) Remove the five bolts and washers from locations 6, 7, 8, 19 and 20 in the outer flange of the stand-by hydraulic pump adapter, allowing the bracket to hang clear.

(b) Remove retaining ring from inside diameter of nut on stand-by hydraulic pump end of the spur gearshaft.

(b) Engage the splines of the immobilizer (PE.29727) with the splines of the spur gearshaft at the

stand-by hydraulic pump end.

(d) Position the immobilizer plate across the adapter flange, with the location pin on the plate in the extraction hole 'E' in the flange, then secure the assembly with four bolts.

(3) Remove the nut from the end of the main hydraulic pump drive shaft (Ref. Fig. 401).

(a) Use punch (PE.34069) and depeen the keywasher on the end of the main hydraulic pump drive shaft.

(b) Remove retaining ring from inside diameter of nut on main hydraulic pump end of the spur gearshaft.

(c) Position the bushing adapter (PE.29725) in the flange of the main hydraulic pump adapter, ensuring that the flat on the bushing adapter is in line with the stepped pin on the pump adapter.

(d) Assemble the splined shaft (PE.29726) to the' reactor plate (PE.29722) and the torque box (PE.35775).

(e) Locate the lugs on the sleeve spanner in the castellations on the nut and the splines on the splined shaft in the splines on the hydraulic pump drive shaft.

(f) Use torque wrench (T2EM1994) and remove the nut and the keywasher from the shaft. Turn torque wrench in a clockwise direction, when viewed from the top, to unscrew the nut.

(g) Remove the splined shaft, reactor plate and the torque box assembly.

NOTE: The immobilizer is not removed from the stand-by hydraulic pump drive at this stage.

(4) Withdraw the adapter.

(a) Use spanner (S3S10652000) and remove the bolts securing the adapter to the gearbox case. Note the associated bracket location and remove with attaching bolts.

(b) Withdraw adapter assembly from gearbox and remove the Corruplus seal.

B. Remove the Sealol Seal from the Adapter.

(1) Position the adapter on the support (S3S11735000). Ensure that the lip of the support locates in the Sealol seal and that the dowel is aligned with the aperture in the adapter.

(2) Position the press pad (S3S11734000) on the adapter flange and while holding the support dowel in alignment, press the Sealol seal from its location in the adapter; remove the adjusting washer from the adapter.

(3) Remove the adapter from the support.

C. Assemble the Sealol Seal to the Adapter.

(1) Establish the adjusting washer thickness required (Ref. Fig. 402).

(a) With the seal mating ring and the seal sleeve positioned on the shaft, assemble the keywasher and the nut to the spur gearshaft. Temporarily tighten the nut using the splined shaft, reactor plate and the torque box assembly.

NOTE: The immobilizer remains in position on the stand-by hydraulic pump drive for this operation.

(b) Remove the nut and keywasher from the spur gearshaft, taking care not to disturb the seal sleeve and seal mating ring.

NOTE: This sequence ensures that the seal sleeve and seal mating ring are in the correct position for the measuring operation.

(c) Measure the distance from the flat face of the seal mating ring to the surface of the gearbox case and record as dimension 'C' (Ref. Fig. 402)

(d) Measure and record the dimensions 'W' and 'Z' for the main hydraulic pump adapter (Ref. Fig. 402).

(e) From recorded dimensions C, W and Z, calculate

the adjusting washer thickness required.

Washer thickness = C - W plus Z - 0.550 in. (13,97 mm)

NOTE: Nominal seal dimension is 0.550 in.

(f) Select the required adjusting washer from the range of four, which vary in thickness in steps of 0.025 in.

(2) Assemble the selected adjusting washer and the Sealol seal in the pump adapter.

(a) Assemble the adapter to the support (S3S10638000). Locate the stepped pin on the adapter with the slot in the support.

(b) Place the adjusting washer in the adapter, then position the Sealol seal, with its carbon face uppermost, above the washer. Use the press pad (S3S10637000) and press the seal and the washer into abutment with the step in the adapter.

(c) Remove the adapter from the support.

D. Install Main Hydraulic Pump Adapter in Gearbox Case.

(1) Locate the new Corruplus seal in the groove in the mounting face of the main hydraulic pump adapter.

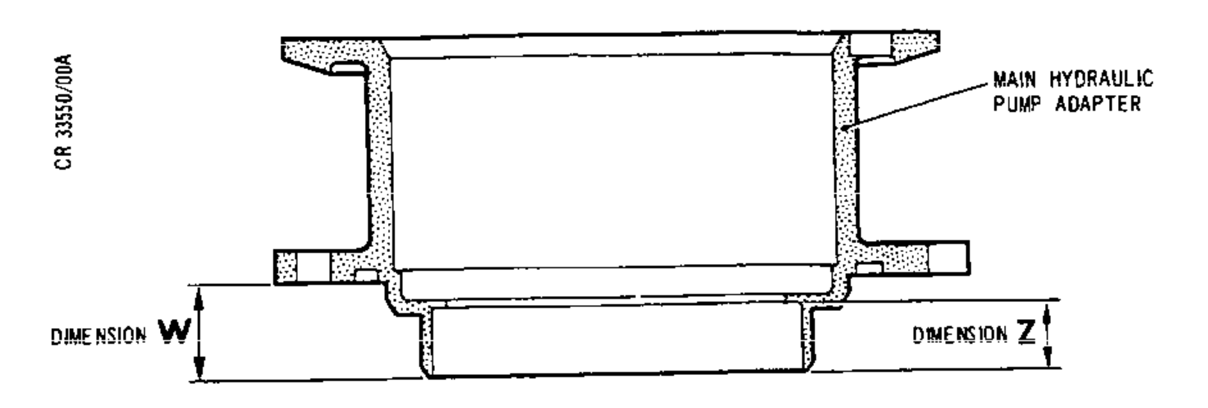
(2) Locate the adapter assembly on the two stepped pins in the gearbox case, with the pin on the adapter uppermost face toward the front cover mounting face.

(3) With lubricant A applied, attach the adapter to the gearbox case with 16 bolts lightly tightened. Locate the bracket with attaching bolts in position noted during removal.

(4) Use the spanner (S3S10652000) and torque-tighten the bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(5) With lubricant A applied, assemble the keywasher and nut to the spur gearshaft.

(6) Torque-tighten the nut to 190 lbf ft (258,0 N.m), turning the torque wrench counter-clockwise as viewed from the top. Use the splined shaft, reactor plate and the torque box assembly (Ref.para.4.A). The immobilizer remains in position during this



KEYWASHER
NUT
SEAL SLEEVE
DIMENSION C
MATING RING
A
GEARBOX CASE
HYDRAULIC PUMP SPUR GEARSHAFT
FLANGED ROLLER BEARING

DIMENSION C —W
Z
A
RELATIVE ASSEMBLED POSITIONS

CMR 72 63 05 4 BAMO

Calculating the Sealol Seal Adjusting Washer
Figure 402

sequence.

(7) Remove the splined shaft, reactor plate and the torque box assembly.

(8) Remove the immobilizer from the standby hydraulic pump drive shaft.

(9) With lubricant A applied, assemble the five bolts and washers to the outer flange of the stand-by hydraulic pump adapter, positioning the bracket at locations 6 and 7 (Ref. Fig. 401). Torque-tighten the bolts to between 90 and 100 lbf in. (10,2 and 11,3 N.m).

(10) Peen the keywasher on the end of the main hydraulic pump drive shaft and lock the shaft nut (Ref. Fig. 403).

(a) Position the clamp assembly (PE.34112) so that the location adapter contacts the nut on the end of the stand=by hydraulic pump drive shaft.

(b) Screw in the knurled adjusting screw at the main hydraulic pump end until the spigot of the clamp assembly locates in the bore of the spur gearshaft and the plunger locates in one of the slots in the nut.

NOTE: When the plunger is engaged with the nut slot, the three peening fingers are correctly positioned for the peening operation.

(c) Check that the plunger has entered the nut slot then use a spanner and screw in the adjusting screw at the main hydraulic pump end to peen the keywasher (Ref. 70-00-09).

(d) Remove the clamp assembly.

(11) Assemble retaining ring to gearshaft nuts.

(a) Assemble a retaining ring to the groove in the inside diameter of the nut at each end of the spur gearshaft.

E. Complete the Installation (Ref.para.6).

5. Renew Oil Seal for Stand-by Hydraulic Pump Drive (Ref. Fig. 401)

MAIN HYDRAULIC PUMP ADAPTER
SLEEVE SEAL
SEAL MATING RINGS
STAND-BY HYDRAULIC ADAPTER ASSEMBLY
STAND-BY HYDRAULIC PUMP ADAPTER
NUT
A
B
CR 33554/00A
SPRUNG LOCATOR
KEYWASHER
SEALOL SEALS
KEYWASHER

ADAPTER
CMR 72 63 05 4 CAM0
A
B

Peening the Keywasher on the Main Hydraulic
Pump Driving Spur Gearshaft
Figure 403

A. Remove Main Pump Adapter from Gearbox (Ref.para.4.A).

B. Remove Stand-by Pump Adapter and Spurgear Drive from Gearbox.

(1) Remove the sleeve seal and seal mating ring from the main pump drive shaft.

(2) Use the punch (PE.34069) and depeen the keywasher on the end of the stand-by pump drive shaft.

(3) Remove the bolts and washers securing the drain elbow, bracket and stand-by hydraulic pump adapter assembly to the gearbox case.

(4) Assemble a puller (PE.29828) into each of the three threaded inserts in the outer flange of the adapter assembly. Screw in the pullers and withdraw the adapter, spur gearshaft and assembled items from the gearbox case.

<u>NOTE:</u> Screw each puller in by an equal amount to keep the adapter assembly square to the gearbox during withdrawal.

(5) Remove the gasket from the adapter mounting face.

C. Remove the Sealol Seal from the Stand-by Pump Adapter.

(1) Remove the nut from the stand-by pump drive end of the spur gearshaft (Ref. Fig. 404).

(a) Position the splined immobilizer (PE.29733) in a suitable bench vice.

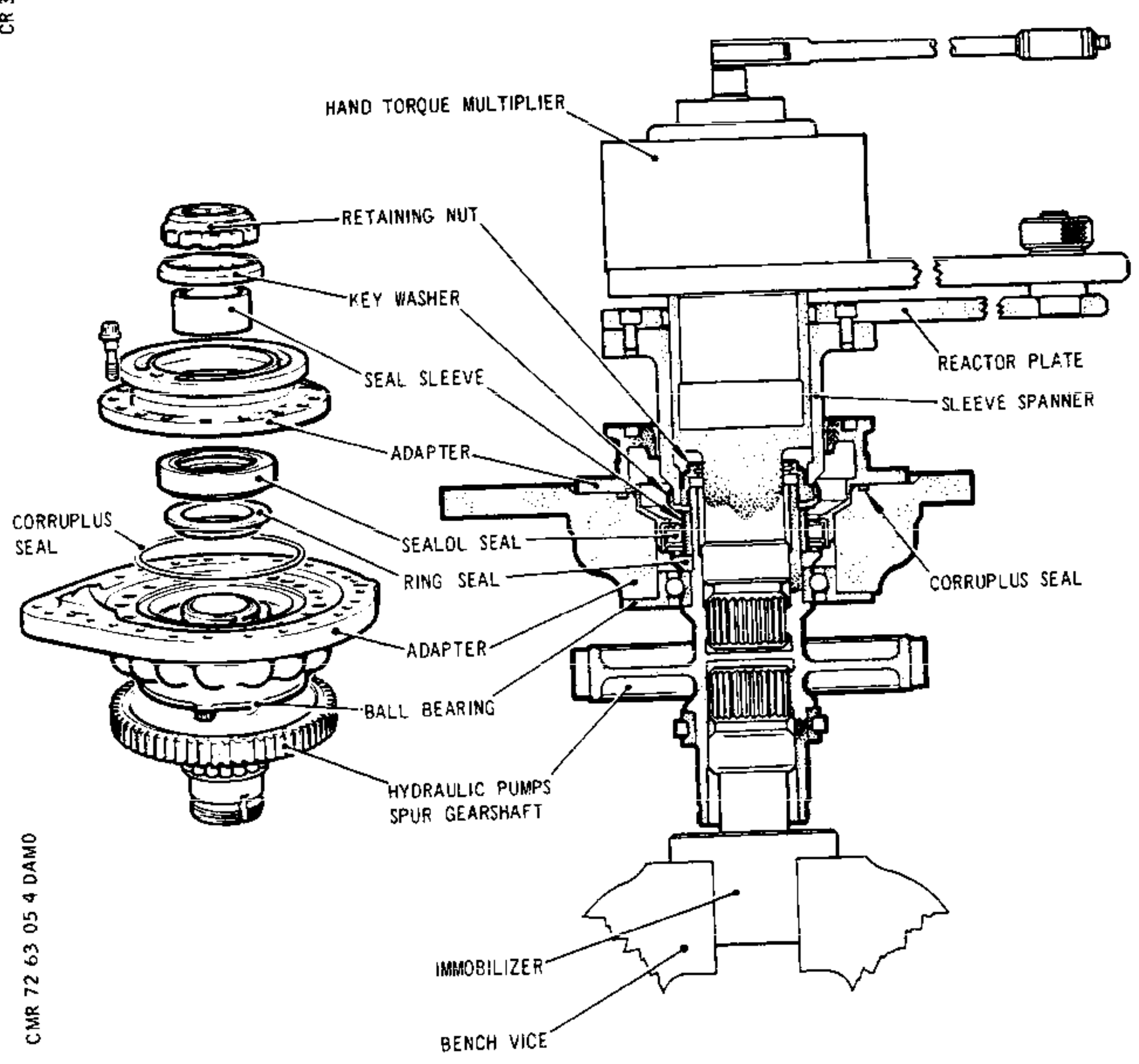
(b) Position the gearshaft so that the splines on the internal circumference at the main hydraulic pump end engage with the splines on the immobilizer.

(c) Assemble the splined shaft (PE.29732) to the reactor plate (PE.29722) and the torque box (PE.35775).

(d) Depeen the keywasher.

(e) Locate the lugs on the sleeve spanner in the castellations on the nut and the splines on the splined shaft in the splines on the hydraulic pump drive shaft.

CR 33559/00A



CMR 72 63 05 4 DAMO

Disassembly and Assembly of Hydraulic Pumps
Spur Gearshaft Pieces
Figure 404

(f) Unscrew and remove the nut and the keywasher from the shaft.

NOTE: Turn the torque wrench in a clockwise direction, when viewed from the top, to unscrew the nut.

(g) Remove the splined shaft, reactor plate and the torque box assembly.

(2) Separate the two adapters.

(a) Unscrew and remove the 17 bolts securing the adapter to the stand-by hydraulic pump adapter, then remove the adapter, together with the Sealol seal and Corruplus seal, from the stand-by pump adapter.

(b) Remove the Corruplus seal from the groove in the adapter mounting face.

(3) Remove the Sealol seal from the adapter.

(a) Position the adapter on the support (S3S11735000). Ensure that the lip of the support is located in the Sealol seal and that the dowel is aligned with the aperture in the adapter.

(b) Position the press pad (S3S11734000) on the adapter flange and while holding the support dowel in alignment, press the seal from its location in the adapter.

(c) Remove the adapter from the support.

D. Assemble the Sealol Seal to the Adapter.

(1) Check the working length for the Sealol seal in the adapter (Ref. Fig. 405).

(a) With the seal mating ring and the seal sleeve in position on the shaft, assemble the keywasher and the nut to the spur gearshaft located in the stand-by hydraulic pump adapter; temporarily tighten the nut.

(b) Remove the nut and keywasher from the spur gearshaft, taking care not to disturb the seal sleeve and seal mating ring.

NOTE: This sequence ensures that the seal sleeve and seal mating ring are in the correct position for the measuring operation.

(c) Measure the distance from the flat face of the seal mating ring to the recessed face of the adapter. Record as dimension 'A'.

(d) Measure and record the dimensions 'X' and 'Y' on the adapter (Ref. Fig. 405).

(e) The working length of the Sealol seal = Dimension 'A' - Dimension 'X' + Dimension 'Y'. The required working length is between 0.530 and 0.590 in. (13,4620 and 14,9860 mm).

NOTE: Selectively assemble the parts, to give the required working length, if the limits are not achieved.

(2) Assemble the Sealol seal in the adapter.

(a) Assemble the adapter to the support (S3S10638000), locating the stepped pin on the adapter with the slot in the support.

(b) Position the Sealol seal, with its carbon face uppermost, in the adapter. Use the press pad (S3S10637000) and press the seal into the adapter.

(c) Remove the adapter from the support.

E. Assemble the Adapter and Sealol Seal to the Gearshaft Assembly.

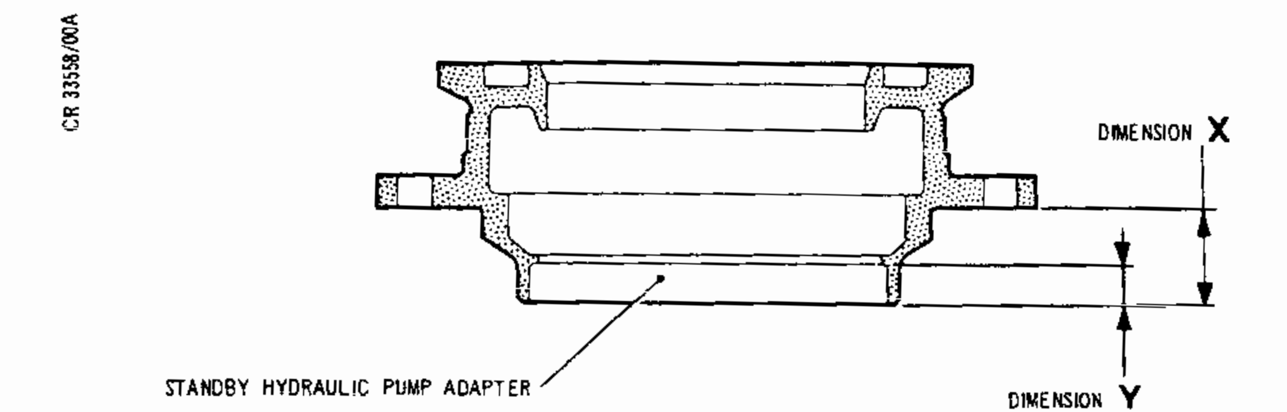
(1) Position the Corruplus seal in the groove in the mating face of the adapter.

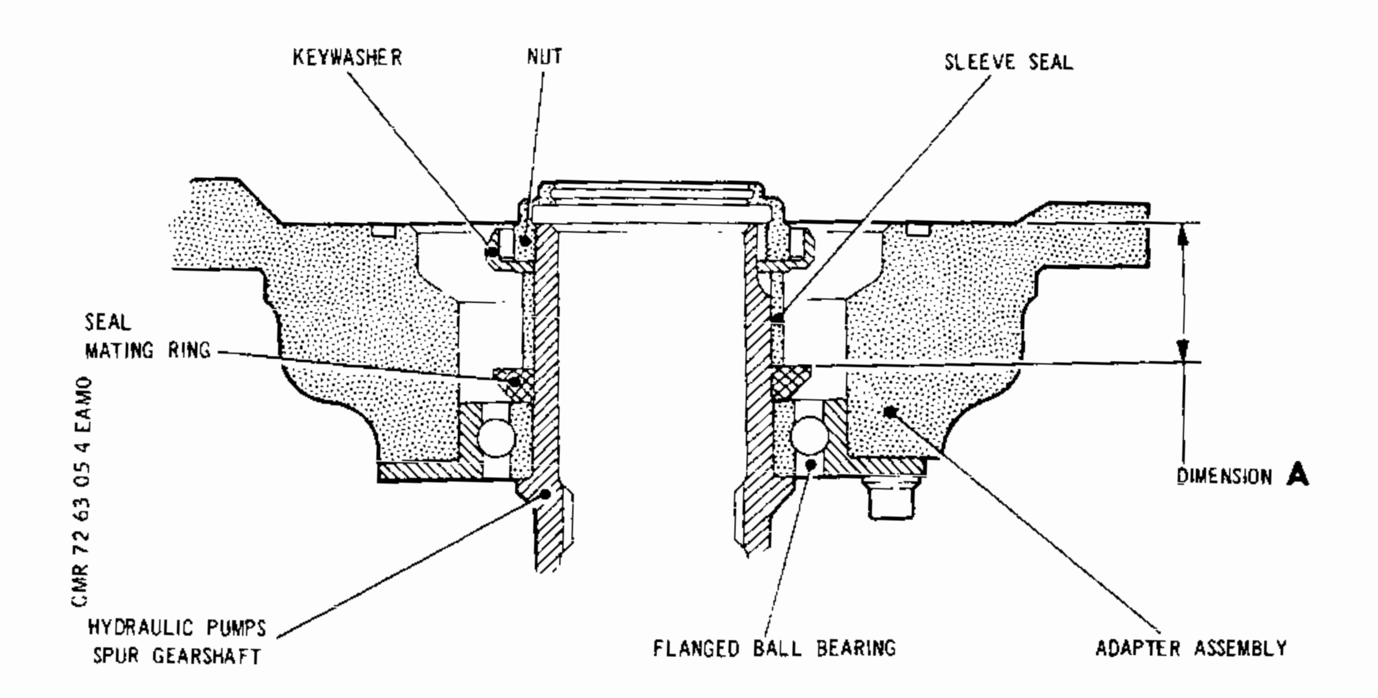
(2) Assemble the adapter on the gearshaft assembly, aligning the hole in the adapter with the stepped pin in the adapter assembly. Secure the two adapters with 17 bolts, torque-tightened between 67 and 73 lbf in. (7,6 and 8,2 N.m), with lubricant A applied.

(3) Assemble the keywasher and the nut on the spur gearshaft.

(4) Torque-tighten the nut on the spur gearshaft with lubricant A applied. Use the splined immobilizer,

CR 3355B/00A





Calculating the Working Length of the Sealol Seal
Figure 405

splined shaft, reactor plate and the torque box (Ref. Fig. 404).

(a) Position the splined immobilizer (PE.29733) in a suitable bench vice.

(b) Position the gearshaft so that the splines on the internal circumference at the main hydraulic pump end engage with the splines on the immobilizer.

(c) Assemble the splined shaft (PE.29732) to the reactor plate (PE.29722) and the torque box assembly (PE.35775).

(d) Locate the lugs on the sleeve spanner in the castellations on the nut and the splines on the splined shaft in the splines on the hydraulic pump drive shaft.

(e) Torque-tighten the nut to 190 lbf ft (258 N.m).

NOTE: Turn the torque wrench in a counter-clockwise direction, when viewed from the top, to tighten the nut.

(f) Remove the splined shaft, reactor plate and torque box assembly from the gearshaft, then remove the gearshaft from the splined immobilizer.

F. Assemble the Stand-by Hydraulic Pump Adapter and Gearshaft Assembly to the Gearbox Case (Ref. Fig. 401).

(1) Assemble the gasket to the flange on the gearbox case, then locate the stand-by hydraulic pump adapter on the hollow pin and engage the teeth of the spur gear with the teeth on the idler gear.

(2) Position the gasket and drain elbow on the adapter at the bolt positions numbered 12 and 13.

(3) Secure the drain elbow, gasket, adapter assembly and gasket with 21 bolts and 19 washers, with lubricant A applied, omitting the five bolts and the bracket from the positions, numbered 6, 7, 8, 19 and 20, at which the immobilizer (PE.29727) is secured. Use two bolts at the drain elbow and the 19 bolts and 19 washers at the remaining positions. Tighten, but do not torque-tighten, the bolts.

NOTE: The immobilizer is fitted before tightening the nut on the main hydraulic pump drive gearshaft.

G. Install the Main Hydraulic Pump Adapter in Gearbox Case (Ref.para.4.D).

H. Torque-tighten the bolts on the outer flange of the stand-by hydraulic pump adapter to between 90 and 100 lbf in. (10,2 and 11,3 N.m) with lubricant A applied.

J. Peen the Keywasher on the End of the Stand-by Hydraulic Pump Drive Shaft and Lock the Nut (Ref. Fig. 403).

(1) Position the clamp assembly (PE.34112) so that the location adapter contacts the nut on the end of the main hydraulic pump drive, then peen the keywasher in a similar manner to the main pump drive keywasher.

K. Complete the Installation (Ref.para.6).

6. Complete the Installation

A. Install the Hydraulic Pumps Oil Drain Tube.

(1) Position the drain tube on the bottom of the gearbox case, then loosely connect the tube at the two spannered connections.

(2) Position the tube on the main hydraulic pump adapter, interposing a gasket on S.B.OL.593-79-3 standard engines, then secure the tube to the adapter with two bolts.

(3) Tighten and wire-lock the two spannered connections.

(4) Attach the tube to the bottom of the gearbox case with the bolt and clamp assembly.

B. Install the Main Hydraulic Pump.

(1) Observe the safety precautions, install the pump and carry out the required checks (Ref.29-00-00, General - Removal/Installation, 29-11-71 or 29-12-71, Removal/Installation).

C. Install Stand-by Hydraulic Pump or Blank Assembly.

(1) If hydraulic pump to be installed - observe the safety precautions, install the pump and carry out

the required checks (Ref.29-00-00, General - Removal/Installation and 29-21-71, Removal/Installation).

(2) If blank assembly is to be installed, proceed as follows:

(a) Assemble a new sealing ring to the blank cover, then position the cover on the stand-by hydraulic pump adapter.

(b) Install the rim clenching clamp on the flange, with spherical washers and spring washers under the nuts.

NOTE: The nuts should be assembled to the eye-bolts from which they were removed and will have been parked accordingly.

(c) Tighten the clamp as detailed in 29-21-71.

(d) Connect and wire-lock the electrical connector to the parking bracket.

D. Remove Tools and Equipment, then Close the Engine Bay Doors.

DRAIN VALVE AND MAGNETIC PLUG ASSEMBLY - SERVICING

1. General

The procedure applicable to this assembly is contained in 72-01-00, Servicing.

DRAIN VALVE AND MAGNETIC PLUG ASSEMBLY - REMOVAL/INSTALLATION

1. General

The drain valve and magnetic plug assembly is installed in the right-hand gearbox.

2. Tools and Equipment

Drift, quick attach/detach nut assembly PE.3778

Drain tube, for drain valve in gearbox
R (Pre.SB.72-9036-419) PE.29023
R (SB.72-9036-419) S3S.20590000

3. Drain Valve and Magnetic Plug Assembly

CAUTION: PROTECT COMPONENTS AND OIL FROM CONTAMINATION.

A. Prepare to Remove Drain Valve and Magnetic Plug Assembly.

(1) Open engine bay front lower door (Ref.71-00-00, Servicing).

(2) Drain oil from right-hand gearbox (Ref.72-01-00, Servicing). Do not install magnetic plug after draining.

B. Remove Drain Valve (Ref. Fig. 401)

(1) Position container under drain valve location to receive filter items and residual oil drainage.

(2) Remove quick attach/detach nut assembly.

(a) Unscrew and remove bolt and spherical washer.

(b) Use the approved drift against the flat face of lug and drive nut in direction to separate locking trunnions until loosened.

(c) Turn nut until threads disengage and align with their withdrawal slots. Remove nut assembly.

(3) Withdraw drain valve together with filter unit and sealing ring squarely from gearbox.

(4) Unscrew drain valve body from filter unit.

NOTE: The spring between the filter and drain

valve flange is a loose item.

(5) Measure and record the quantity of oil drained from the system.

C. Install Drain Valve.

(1) Ensure that quick attach/detach nut assembly components are serviceable.

CAUTION: ENSURE THAT FILTER UNIT IS FULLY ASSEMBLED TO DRAIN VALVE BODY.

(2) Assemble drain valve body to filter unit.

(a) Position spring on drain valve.

(b) Screw drain valve body into filter until the thread of the filter enters the undercut provided.

(c) Check spring action.

(3) Apply lubricant A (Ref.70-00-01, Servicing and Storage Materials) to quick attach/detach nut assembly threads and abutment flanges, and to clamping bolt, spherical nut and washer.

R (4) Lubricate the toroidal sealing ring (Ref.70-00-03) and assemble to flanged adapter.

(5) Enter filter with drain valve into adapter ensuring that slots in drain valve flange engage lugs on adapter.

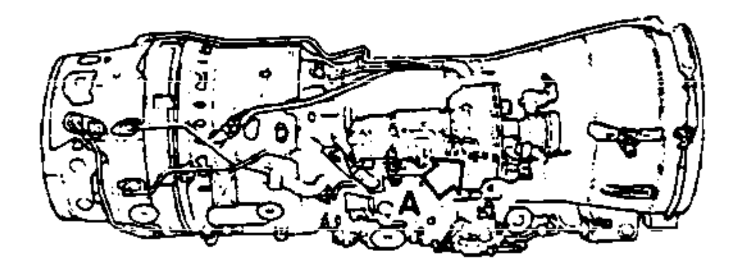
(6) Hold drain valve flange hard against sealing ring through base of quick attach/detach nut assembly and engage threads of nut with those of adapter as far as possible by hand.

CAUTION: ENSURE THAT THREADS HAVE ENGAGE FREELY BEFORE APPLYING TIGHTENING FORCE TO NUT ASSEMBLY.

(7) Position spherical washer on clamping bolt then insert bolt through fixed locking trunnion to engage spherical nut of nut assembly trunnion by hand. Screw in clamping bolt and check that the locking (run-down) torque is within 3 to 10 lbf in. (0,3 and 1,1 N.m).

(8) Tighten and lock nut assembly.

CR 31226/00D
BS00000031/4





SPHERICAL WASHER
QUICK ATTACH/DETACH ADAPTER
SCAVENGE FILTER LOCATION
SEALING RING
DRAIN TUBE
FILTER
MAGNETIC PLUG (PRE SB.OL.593 -72-9036-419)
A
R
R O-SEAL
R
R
MAGNETIC PLUG (TO SB.OL.593 -72-9036-419)
DRAIN VALVE BODY
QUICK ATTACH/DETACH NUT ASSEMBLY

Drain Valve and Magnetic Plug Assembly
Installation Detail
Figure 401

(a) Ensure that nut assembly is hand-tight.

(b) Torque-tighten clamping bolt to 60 lbf in. (6,8 N.m).

(9) Finally tighten clamping bolt.

(a) Slacken bolt and ensure that locking (run-down) torque is within limits 3 to 10 lbf in (0,3 and 1,1 N.m).

(b) Torque-tighten bolt to 60 lbf in (6,8 N.m).

D. Complete the Installation.

R CAUTION: IT IS OF THE UTMOST IMPORTANCE TO ENSURE
R THAT ALL MAGNETIC PLUG ASSEMBLIES ARE
R FULLY TORQUE-TIGHTENED ON ASSEMBLY, ALSO,
R WHEN FITTING ASSEMBLIES MODIFIED TO
R SB.OL.593-72-9036-419 STANDARD A
R SERVICEABLE '0' SEAL MUST BE FITTED.
R FAILURE TO DO THIS CAN RESULT IN OIL
R LEAKAGE IN FLIGHT WHICH MAY NOT BE
R APPARENT DURING GROUND CHECKS/RUNNING.

(1) Apply lubricant A, screw magnetic plug into drain valve and torque-tighten to 30 lbf ft. (40 N.m).

(2) With oil tank full (Ref.12-13-79) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to the amount drained during the removal procedure.

(3) Close engine bay doors (Ref.71-00-00, Servicing).

DRAIN VALVE AND MAGNETIC PLUG ASSEMBLY - INSPECTION/CHECK

1. General

The procedure applicable to this assembly is contained in 72-01-00, Inspection/Check.

Printed in England

DRIVE, PULSE PROBE AND HOUSING - DESCRIPTION AND OPERATION

1. General (Ref. Fig. 001)

The pulse probe drive and housing includes a drive shaft, a quillshaft and a sump case assembly located at the bottom of the compressor intermediate case. The drive shaft extends upward through vane No. 4 of the intermediate case to the internal accessory drives.

2. Drive Shaft

External splines at the upper end of the drive shaft engage splines in an accessories drive bevel gear. The lower end of the drive shaft is shouldered to engage a supporting journal ball bearing located in the housing. The shaft is retained in the bearing by a nut screwed on the shaft.

The lower end of the drive shaft protruding below the bearing is formed in a toothed wheel with its periphery near the pulse probe location.

The drive shaft engages a quillshaft which is retained in position in the bottom of the housing by a circlip. Splines at the upper end of the quillshaft engage those in the lower end of the drive shaft. A squared recess in the lower end of the quillshaft provides for the engagement of a hand turning tool while a shear neck on the shaft provides protection against overload.

3. Sump Case Assembly

The sump case assembly, bolted to the base of the compressor intermediate case houses the drive shaft journal ball bearing and carries the lower end of the drive shaft and the quillshaft. The outlet of the oil scavenge tube surrounding the drive shaft, opens into the sump case. The LP pulse probe is bolted to the case front face and the engine oil pressure switch and oil pressure transmitter are bolted to the case rear face.

A cover bolted to the bottom of the sump case provides sealed access to the quillshaft. The face exposed by the cover removal provides a mounting face for engine turning equipment. A connection is provided for the scavenge oil external tube.

4. Operation

The external splines at the upper end of the drive shaft

CR 31137/00A

BEVEL GEAR

DRIVE SHAFT

A

OIL PRESSURE TRANSMITTER

SUMP CASE ASSEMBLY

CMR 72 64 00 0 AAMO

NUT

QUILL SHAFT

TOOTHED WHEEL

A

LP PULSE PROBE

ENGINE TURNING GEAR COVER

OIL PRESSURE SWITCH

Drive, Pulse Probe and Housing
Figure 001

engage the bevel gear of the engine accessories drives, and transmit the drive to the toothed wheel formed at the lower end of the shaft. The periphery of the toothed wheel revolves in close proximity to the pulse probe pole piece. The action of the wheel teeth passing the pole piece produces a signal which is in proportion to LP compressor rotor shaft speed.

Scavenge oil from the driving bevel gear bearings, together with oil from the compressor thrust bearings, passes through the sump case to the external oil tube connection.

Installation and use of the engine turning equipment after removal of the access cover is described in 72-09-01.

PULSE PROBE DRIVE AND HOUSING - REMOVAL/INSTALLATION

1. General

The following procedures cover the removal and installation of the pulse probe drive quillshaft following a failure of the quillshaft.

2. Pulse Probe Drive Quillshaft (Ref. Fig. 401)

A. Remove Quillshaft.

(1)+ Open the engine bay front lower door (Ref.71-00-00, Servicing).

(2) Remove the seven bolts retaining the cover to the pulse probe drive and housing flange, then withdraw the cover.

(3) Remove the retaining ring which retains the quill-shaft in the sump case, then withdraw the broken
R quillshaft using the threaded extractor hole provided
R (Ref. S.B.OL.593-72-3).

B. Prepare to Install the New Pulse Probe Drive Quillshaft.

(1) Remove and discard the gasket from the sump case flange.

(2) Clean the area, inside the sump case, surrounding the pulse probe drive quillshaft.

(a) Wipe over the affected area with a clean cloth, ensuring that any metal particles are removed.

C. Install the New Pulse Probe Drive Quillshaft (Ref. Fig. 401)

(1) Insert the splined end of the quillshaft into the end of the pulse probe drive splined shaft and secure it with the retaining ring as shown.

R (2) Ensure that the cover and new gasket are to the same
R Service Bulletin standard (Ref. S.B.OL.593-72-41),
R then assemble gasket and cover to the pulse probe drive and housing flange and secure with seven bolts torque-tightened to between 85 and 95 lbf in (9,6 and 10,7 N.m) with lubricant A applied.

(3) Close engine bay front lower door (Ref.71-00-00,

CR 33548 00A

A

OIL PRESSURE TRANSMITTER

OIL PRESSURE SWITCH

LP PULSE PROBE

A

SUMP CASE

SHEARING QUILL SHAFT

RETAINING RING

GASKET

COVER

CMR 72 64 00 4 AAMO

Attachment Details of Pulse Probe Drive and
Housing Quillshaft
Figure 401

Servicing) on completion of work.

MAIN OIL PUMP - DESCRIPTION AND OPERATION

1. General

The main oil pump is mounted in the bottom of the left-hand gearbox and forms its base. The pump maintains an oil supply to the engine lubrication system and returns scavenge oil to the tank. The oil supply and return systems are described in 79-00-00 and the engine lubrication system in 72-01-00.

2. Description

The oil pump comprises a pressure pump and four scavenge pumps as shown in the illustration (Ref. Fig.001). Each pump is of the spur gear type and is housed in a pump case. These cases, with their gears, are mounted one above the other and bolted together to form the main oil pump case. The pressure pump gears and case occupy the lowermost position.

The four scavenge pump driving gears are coupled together by two externally splined quillshafts. The upper quillshaft couples the gearbox drive shaft to the HP turbine bearing scavenge pump driving gear, which in turn is coupled to the remaining driving gears by the lower quillshaft. The driven gear of the HP turbine bearing scavenge pump is supported by the integral shaft of the LP turbine bearing scavenge pump driven gear which is in splined engagement with with the integral shafts of the driven gears of the other scavenge pumps, and the driving gear of the pressure pump. The pressure pump driven gear has an integral shaft which is supported separately by bushes in the casing.

One pressure and three scavenge filters, shown in the
R illustration (Ref. Fig.002 and 003) are housed in the base of the pump. The pressure pump delivery passage connects to the pressurizing valve and pressure filter. S.B.OL.593-72-49 introduces a fine mesh, 'double flow', main oil pump delivery pressure filter, with a brazed construction and perforated plate frames, to replace the gauze strainer type.

Each of the three scavenge filter strainers is located in the scavenge inlet to its respective pump. S.B.OL.593-72-8448-226 introduces a scavenge filter assembly with an inner filter unit of reduced overall length to replace the existing filter assembly which incorporates an extended support ring on the inner filter unit. The filter strainer for the LP compressor front bearing scavenge pump is located in the bearing oil scavenge tube that connects to the pump case at

its pump inlet. A drain valve and drain aperture sealed by a blanking plug is incorporated in each of the three scavenge
R filter assemblies in the main oil pump.

S.B.OL.593-72-419 introduces secondary sealing to the magnetic plugs and filter covers, and deletes the filter cover drain plugs to reduce the possibility of oil leakage.

S.B.OL.593-72-27 introduces non-reversible retaining rings on the pressure and scavenge filters to eliminate the possibility of incorrect assembly. The new retaining rings have an unthreaded extension of the bottom edge which acts a a baulking feature and prevents insertion of the ring, into the threads of the pump case, in the inverted position.

3. Operation (Ref. Fig.004)

Oil from the storage tank enters the pressure pump, circulates between the gear teeth and pump case and is discharged into the delivery passage to pass via the pressure filter, to the engine lubrication system, main bearings, accessory drives and gears. To prevent excessive oil being retained in the bearing chambers after engine shut-down, the pressurizing valve located in the pressure delivery passage closes as pump output decreases, and subsequent decreasing pump output returns direct to the tank via the restrictor in the pump delivery passage.

The pressure relief valve controls the output pressure of the pump at a constant value above the internal air pressure and ensures that oil pressure is greater than air pressure in the main bearing chambers. To maintain this differential, gearbox air pressure supplements the spring pressure acting to close the pressure relief valve. Any change in gearbox air pressure results in a compensating change in pump output pressure under control of the relief valve.

The four scavenge pumps return the scavenge oil from the engine lubrication system to the storage tank. The scavenge oil enters each pump via its filter and is circulated through the pump. Converging outlets combine to form a common outlet to the return oil system. Internal passages in the pump cases connect with the scavenge outlet to give a continuous flow of oil through a restrictor jet back to the oil tank. This permanent bleed assists in priming during engine start-up and in the recovery of pump outlet pressure, should the oil supply be interrupted due to negative 'G' conditions in flight.

CR 31299 00A

QUILL SHAFTS

PUMP CASES

No 4 SCAVENGE PUMP

No 5 SCAVENGE PUMP

No 2 AND 3 SCAVENGE PUMP

No 1 SCAVENGE PUMP

PRESSURE PUMP

OIL TUBE RETURN TO TANK

OIL TUBE FROM OIL TANK

OIL PUMP

CMR 72 65 00 0 AAMO

BEARING FEED TUBE

BEARING SCAVENGE TUBES

BEARING SCAVENGE TUBES

Oil Pump - Gears and Drives
Figure 001

CR 31344/00C
BS0000037/3

PRESSURE RELIEF VALVE

RESTRICTOR

LH GEARBOX

OIL PUMP

LP AND HP COMPRESSOR THRUST BEARINGS SCAVENGE FILTER

HP TURBINE BEARING SCAVENGE FILTER

LP TURBINE BEARING SCAVENGE FILTER

CHECK VALVE

DRAIN VALVE

MAGNETIC PLUG

R

PRESSURE FILTER

SCAVENGE FILTER (TYPICAL)

Oil Pump - Filters
(Pre SB.OL.593-72-9036-419)
Figure 002

CR 36651/00A

PRESSURE RELIEF VALVE

RESTRICTOR

LH GEARBOX

OIL PUMP

LP AND HP COMPRESSOR
THRUST BEARINGS
SCAVENGE FILTER

HP TURBINE BEARING
SCAVENGE FILTER

LP TURBINE BEARING
SCAVENGE FILTER

CHECK VALVE

DRAIN VALVE

PRESSURE FILTER

SCAVENGE FILTER (TYPICAL)

R Oil Pump - Filters
R (SB.OL.593-72-9036-419)
R Figure 003

CR 31300 00A

CMR 72 65 00 0 CAMO

FROM LP COMPRESSOR FRONT BEARING VIA EXTERNAL FILTER

FROM HP AND LP COMPRESSOR THRUST BEARINGS AND LEFT HAND GEARBOX

FROM HP TURBINE BEARING

FROM LP TURBINE BEARING

TO BEARINGS AND DRIVES

SCAVENGE FILTERS

SCAVENGE FILTER

SCAVENGE PUMPS

FROM TANK

PRESSURE PUMP

PRESSURIZING VALVE

PRESSURE FILTER

RESTRICTOR

GEARBOX INTERNAL AIR PRESSURE

PRESSURE RELIEF VALVE

PRESSURE

SCAVENGE

TO TANK VIA COOLER

Oil Pump - Oil Flow (Schematic)
Figure 004

R

MAIN OIL PUMP - SERVICING

1. General

The procedure applicable to the filters of the main oil pump is contained in 72-01-00, Servicing.

Printed in England

MAIN OIL PUMP - REMOVAL/INSTALLATION

1. General

Removal and installation procedures for the main oil pump as an assembly and the oil pressure relief valve are given in paragraphs 2 and 3 respectively.

2. Main Oil Pump (Ref. Fig.401 and 402)

R A. Tools and Equipment

R Joint splitter assembly S3S11690000

R B. Prepare to Remove Oil Pump.

(1) Open engine bay front lower door (Ref.71-00-00, Servicing).

(2) Drain left-hand gearbox of oil (Ref.72-01-00, Servicing)

R C. Remove Oil Pump.

(1) Position a receptacle to catch oil drainage and remove attachment bolts securing the following oil tubes to the pump. Attach identification labels to bolts removed from each tube flange.

NOTE: Associated brackets will remain in position attached to clipping.

(a) Oil supply tube from tank.

(b) LP compressor front bearing scavenge tube.

(c) Oil feed tubes to LP compressor front bearing and LP and HP compressor thrust bearings.

(d) Oil return tube to cooler.

(e) LP turbine bearing scavenge tube.

(f) LP and HP compressor thrust bearings scavenge tube.

(g) HP turbine bearing scavenge tube.

R (2) Separate each tube flange from the oil pump and
R measure the quantity of oil drained. Where diffi-
R culty is experienced in separating joint faces, use

CR 31219/00A

HYDRAULIC CONNECTOR BLOCK ASSEMBLY

RETURN TO OIL COOLER

DRAINS TUBE BRACKET

COUNTERSUNK WASHER

ELECTRICAL HARNESS AND SEAL FAILURE DRAIN TUBE BRACKET

FEED FROM TANK

OIL TRANSFER COVER

LP COMPRESSOR FRONT BEARING SCAVENGE

HP TURBINE BEARING SCAVENGE

LP AND HP COMPRESSOR THRUST BEARINGS SCAVENGE

LP COMPRESSOR FRONT BEARING FEED

LP TURBINE BEARING SCAVENGE

A

LP AND HP COMPRESSOR THRUST BEARINGS FEED

CMR 72 65 00 4 AAM0

Main Oil Pump and Location Detail
Figure 401

R the joint splitter assembly as follows:

R (a) Unscrew the tool and bring the wedge block
R to the withdrawn position.

R (b) Locate the tool on the joint and hold the
R pad against the side of the tube flange and
R the tube mounting boss on the oil pump.

R (c) Screw in the wedge block, until its levelled
R face contacts the tube flange and its edge
R enters squarely into the joint.

R (d) Continue to screw in the wedge block until it
R penetrates the joint sufficiently to separate
R the tube flange from the pump.

R (3) Detach seal failure drains tube clamp assembly and electrical harness clamp from bracket on oil transfer cover.

R (4) Remove bolts and washers securing fuel heater steady bracket to bracket on oil pump flange.

R (5) Detach tube clamp assemblies and electrical lead clamps from brackets on oil pump flange.

R (6) On engines No. 2 and No. 4 - remove the hydraulic connector block assembly mounting bracket.

(a) Remove nuts, bolts and washers securing connector block to the mounting bracket (Ref. Fig. 401).

(b) Remove nuts securing mounting bracket to pillar bolts and detach bracket from main oil pump flange.

R (7) Support pump and remove nuts, bolts and flat washers securing pump to gearbox; detach support brackets as bolts are removed.

R (8) Screw three 0.250 in., 28 UNF bolts into the extraction holes in the gearbox and oil pump flanges and lower oil pump away squarely to disengage drive shaft. Remove pump from engine.

R D. Install Oil Pump.

(1) If a new pump is to be installed, transfer the seal failure drains tube and electrical harness support

bracket from existing pump to the new pump. Apply lubricant A (Ref.70-00-01, Servicing and Storage Materials) to bolts and torque-tighten to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(2) Check that the three flanged pins are installed in the gearbox flange at the positions indicated in the illustration (Ref. Fig. 402).

(3) Assemble a gasket to oil pump flange.

(4) Lift pump to its location on gearbox and engage drive shaft. Check visually that hollow pin is correctly aligned with its location in gearbox flange and that the three flanged pins engage the oil pump flange locations. Support pump in position.

(5) Secure pump to gearbox.

NOTE: Retaining bolts are inserted with heads at gearbox flange unless otherwise stated.

(a) Apply lubricant A to attachment bolts and nuts. For bolt lengths and corresponding locations refer to the illustration (Ref. Fig. 402).

(b) At positions A locate twelve 1.688 in. long bolts. Place a flat washer under boltheads where brackets are not secured and then insert and lightly tighten bolts. Locate brackets as shown, place flat washers between brackets and gearbox flange, insert bolts and lightly tighten.

(c) At positions B, locate D-trap washer on oil pump flange and insert three D-headed pillar bolts. Retain pillar bolts with flat washers and nuts lightly tightened.

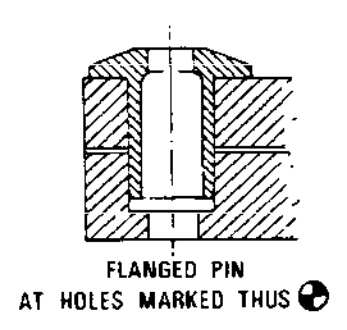
(d) At positions C insert six, 1.688 in. long bolts with flat washers under heads. Retain bolts with flat washers and nuts lightly tightened.

(e) At positions D, locate three, 3.750 in. long bolts with flat washers under heads, insert bolts from oil pump flange and retain with flat washers and nuts lightly tightened.

(f) At position E, insert 1.688 in. long bolt and

CR 31220/D0A

BOLT DESCRIPTION	QUANTITY	LOCATION
'D' HEAD PILLAR	3	B
3·750 IN. LONG	3	D
2·000 IN. LONG	1	G
1·812 IN LONG	4	HJ
1·750 IN. LONG	2	F
1·688 IN. LONG	24	ACEK



GLAND DRAIN TUBE BRACKET
EXTRACTION HOLE
ELECTRICAL HARNESS BRACKET
FUEL HEATER BRACKET
EXTRACTION HOLE
SEAL FAILURE DRAIN TUBE BRACKET
JURY SUPPORT BRACKET
AIRCRAFT FUEL SEAL FAILURE DRAIN TUBE BRACKET
ELECTRICAL HARNESS BRACKET
HOLLOW PIN
EXTRACTION HOLE
SEAL FAILURE DRAIN TUBE BRACKET
ELECTRICAL HARNESS BRACKET

CMR 72 65 00 4 BAMO

Pump Flange Bolt Location Detail
Figure 402

retain with a flat washer and nut lightly tightened.

(g) At positions F, insert two, 1.750 in. bolts with flat washers under heads. Assemble flat washers followed by bracket to bolts and retain with nuts lightly tightened.

(h) At position G, insert 2.000 in. long bolt and lightly tighten.

(j) At positions H, place flat washers between bracket and gearbox flange, insert two, 1.812 in. long bolts and lightly tighten.

(k) At positions J, place flat washers between seal failure drains tube bracket and gearbox flange. Insert two, 1.812 in. long bolts and assemble flat washers followed by electrical harness bracket and nuts lightly tightened.

(l) At positions K with brackets located as shown, screw in and lightly tighten five, 1.688 in. long bolts.

(m) Torque-tighten all flange bolts in sequence of diametrically opposed pairs to between 90 and 100 lbf in. (10,2 and 11,3 N.m).

(6) Attach and secure seal failure drains tube clamp and electrical harness clamp to bracket on oil transfer cover. Apply lubricant B to bolt and torque-tighten to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(7) Attach and secure gland drain tube clamp assembly to support bracket with a bolt, washer and nut. Apply lubricant A and torque-tighten to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(8) On engines No. 2 and No. 4 - install the hydraulic connector block assembly and mounting bracket.

(a) Secure mounting bracket to pillar bolts on the main oil pump flange with three nuts as shown in the illustration (Ref. Fig. 401). Torque-tighten nuts to between 90 and 100 lbf in. (10,2 and 11,3 N.m).

(b) Secure connector block assembly to mounting bracket with bolts, countersunk washers, plain

washers and nuts as shown in the illustration (Ref. Fig. 401). Torque-tighten the two upper bolts to between 60 and 70 lbf in.(6,8 and 7,9 N.m) and the four lower bolts to between 50 and 60 lbf in. (5,6 and 6,8 N.m).

(9) Secure fuel heater steady bracket to bracket mounted on gearbox flange with two bolts and washers. Check that bracket serrations are correctly aligned, apply lubricant B to bolts and torque-tighten to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(10) Attach and secure electrical harness clamp to support bracket at positions J with a bolt and nut torque-tightened to between 85 and 95 lbf in. (9,6 and 10,7 N.m).

(11) Assemble gaskets at joint flanges and secure the following oil tubes to pump. Apply lubricant B to bolts and torque-tighten to the figures quoted.

(a) HP turbine bearing scavenge tube; torque-tighten bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(b) LP and HP compressor thrust bearings scavenge tube; torque-tighten bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(c) LP turbine bearing scavenge tube; retain bracket with the two longer bolts and torque-tighten to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(d) LP compressor front bearing scavenge tube; torque-tighten bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(e) Feed tube to LP compressor front bearing and LP and HP compressor thrust bearings; retain bracket, positioning the bolt with wire-locking facility in bracket upper hole. Torque-tighten bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m) and wire-lock thrust bearings feed tube union nut.

(f) Oil supply tube from tank; torque-tighten bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

(g) Oil return tube to oil cooler; torque-tighten bolts to between 67 and 73 lbf in. (7,6 and 8,2 N.m).

E. Complete the Installation.

(1) With the oil tank full (Ref.12-13-79, Servicing) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to the total amount drained during removal procedure.

(2) On completion of work, close engine bay door (Ref. 71-00-00, Servicing).

3. <u>Oil Pressure Relief Valve</u> (Ref. Fig. 403)

A. General

The procedures detailed in this paragraph are applicable to both pre S.B.OL.593-72-8 and S.B.OL.593-72-8 standards.

B. Tools and Equipment

R Set adaptor, torque S3S.20558000

C. Prepare to Remove Relief Valve.

(1) Open engine bay front lower door (Ref.71-00-00, Servicing).

(2) Drain left-hand gearbox of oil (Ref.72-01-00, Servicing).

D. Remove the Relief Valve.

(1) Unscrew and remove the valve cap and seal.

(2) Unscrew and remove the locknut. Ensure that the adjuster setting is not altered during this procedure.

(3) Note the number of turns required and screw the adjuster into the retainer sleeve as far as possible without using excessive force.

(4) Screw the peg spanner nut onto the retainer sleeve and at the same time ensure the spanner pegs engage with the slots in the retainer sleeve.

(5) Unscrew and remove the retainer sleeve. Remove the peg spanner.

(6) Remove adjuster and spring from retainer sleeve.

(7) Remove valve and valve guide from relief valve housing.

E. Install the Relief Valve.

(1) Apply lubricant A (Ref.71-00-01, Servicing and Storage Materials) to valve and valve guide mating surfaces.

(2) Insert valve and valve guide into the relief valve housing.

(3) Apply lubricant A to threads of retainer sleeve and adjuster.

(4) Insert spring into adjuster, screw adjuster into retainer sleeve to give sufficient clearance between the sleeve slots and adjuster to allow for the attachment of the peg spanner.

(5) Screw the peg spanner nut onto the retainer sleeve and at the same time ensure the spanner pegs engage with the slots in the retainer sleeve.

(6) Screw the retainer sleeve into the relief valve housing and torque-tighten to between 290 and 310 lbf in. (33 and 35 N.m). Remove peg spanner.

(7) Screw the adjuster into the retainer sleeve as far as possible without using excessive force.

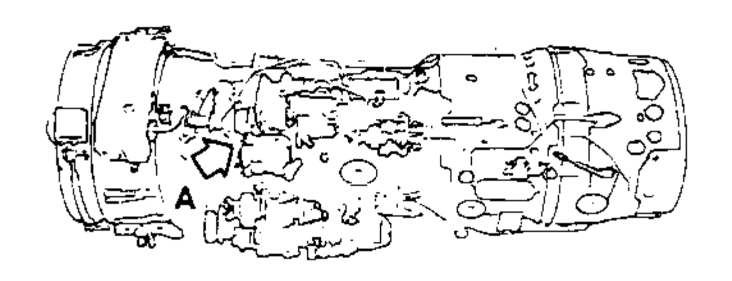
(8) Screw the adjuster out of the retainer sleeve the same number of turns as that noted during the removal procedure and obtain a relief valve setting near the original setting.

(9) With lubricant A applied, screw locknut onto adjuster and torque-tighten to between 170 and 190 lbf in. (19,2 and 21,5 N.m). Ensure the adjuster setting is not altered during this procedure.

(10) With the oil tank full (Ref. 12-13-79,Servicing) and the overflow drain connection drain plug installed, add a quantity of oil to the tank equivalent to that drained during removal procedure.

(11) Carry out an engine run and check the oil pressure reading (Ref.71-00-00, Adjustment/Test) and adjust the relief valve, to obtain an acceptable oil

CR 33767/00A



RELIEF VALVE HOUSING

MAIN OIL PUMP

A

SEAL

RETAINER SLEEVE

SPRING

PRESSURE PUMP CASE

CMR 72 65 00 4 CAM0

PRE SB. 72-8

LOCKNUT

ADJUSTER

VALVE

VALVE GUIDE

CAP

SB. 72-8

Oil Pressure Relief Valve Details
Figure 403

pressure reading, as detailed in 72-01-00, Adjustment/ Test.

(12) On satisfactory completion of check, install and wire-lock valve cap.

(a) With lubricant A applied, install a serviceable seal (Ref.70-00-03, Sealing Devices) and screw the cap onto the retainer sleeve.

(b) Torque-tighten the cap to between 170 and 190 lbf in. (19,2 and 21,5 N.m).

(c) Wire-lock the cap to the lug on the oil pump case.

F. Complete the installation.

(1) Close the engine bay front lower door (Ref.71-00-00, Servicing).

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MAIN OIL PUMP - ADJUSTMENT/TEST

1. General

   For information on the adjustment of the main oil pump relief valve refer to Chapter 72-01-00, Adjustment/Test.

END OF THIS SECTION

NEXT